HydroTherm®

HeatNet® On Board®

KN Series

Gas-fired direct vent Cast iron boilers

Models KN-6 through KN-30

HeatNet® manual

Control adjustment and operation instructions for Hydrotherm firmware version 3.49

This instruction manual applies only to Hydrotherm firmware version 3.49 on version 2.x control boards. Current firmware is backwards compatible with version 1.x boards, but some current features may not be available. To replace firmware on an existing boiler, contact the factory to obtain the original firmware file or for assistance in applying current firmware to an older version control board.

Also read and follow:

KN-Series Gas Boiler Installation and Operating Instructions

This manual is intended only for use by a qualified heating installer/technician. Read and follow this manual, all supplements and related instructional information provided with the boiler. Install, start and service the boiler only in the sequence and methods given in these instructions. Failure to do so can result in severe personal injury, death or substantial property damage.

⚠WARNING

Do not use the boiler during construction. Construction dust and particulate, particularly drywall dust, will cause contamination of the burner, resulting in possible severe personal injury, death or substantial property damage. The boiler can only be operated with a dust-free air supply. Follow the instruction manual procedures to duct air to the boiler air intake. If the boiler has been contaminated by operation with contaminated air, follow the instruction manual guidelines to clean, repair or replace the boiler if necessary.

Affix these instructions near to the boiler. Instruct the building owner to retain the instructions for future use by a qualified service technician, and to follow all guidelines in the User's Information Manual.

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Introduction

The KN-Series HeatNet Control

The KN-Series boiler control is designed to provide the KN-Series of boilers with an integrated boiler management system on every boiler. Designed for the Air-Fuel coupled KN-Series boilers, the KN-Series HeatNet control provides for optimized heating efficiency without the need for a "wall mount control". Since the KN-Series modular control method is based on digital communications, analog control signals are not required. Although the use of analog control signals is still supported (4-20mA control loops and 0-10vdc (20mA minimum) control voltages), a higher level of control precision, repeatability, and feedback is gained with digital communications control.

With the KN-Series, optimized heating efficiency is accomplished by setting the Modulation Maximum (Mod-Max) setting to exploit the inverse efficiency curve. This value can be adjusted so that as each boiler is added, it operates at its maximum turndown. This allows the maximum number of boilers to operate at their lowest inputs, until all boilers are firing. Once all boilers are firing, full range modulation control is allowed. An outdoor reset function is also provided to assist in the optimized heating efficiency of the KN- Series boilers.

The KN-Series boiler with the KN-Series H-Net control, can be operated in multiple ways:

1. As a stand-alone boiler.
2. A boiler in a Boiler Network using the HeatNet® (H-Net®) protocol.
3. A member boiler to a boiler management system with multiple input control methods.

The primary purpose of the control is to maintain the boiler water temperature at the supply or the header sensor using a target setpoint. While performing this task, the control also monitors dedicated external limits in a limit string and provides an orderly shutdown and fault indication in the event of a tripped limit. The monitored limits include a HIGH LIMIT AQUASTAT, LOW WATER CUTOFF, GAS PRESSURE, FLOW, IGNITION CONTROL fault, GAS VALVE alarm, VARIABLE FREQUENCY DRIVE alarm, and other optional or user selectable limits.

NOTICE The HIGH LIMIT circuit is independent of the control and shuts down the ignition control and the boiler if the control board or other component of the boiler was to malfunction. The control will continue to function and report the fault, but its ability to control the boiler will end.

Each KN-Series boiler employing this control can function as either a master or a member. This allows one boiler (Master) to be in control of target temperature. The other boilers (Members) only respond to the commands issued by the Master. If using an external control, all boilers can be setup as members. The following will define the roles of master and member.

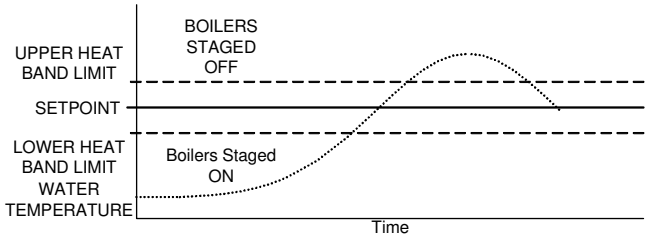
Master

A boiler becomes a master when a temperature sensor is connected to the J10 "SYS/DHW HEADER" terminals. The sensor is auto-detected.

The master senses and controls the common system header/loop water temperature using a system setpoint. It uses any boilers it finds (over the H-Net communications cable) to accomplish this. It can also monitor the Outside Air (OA) temperature to provide outdoor reset functionality. **Only one master is allowed in a system.**

When operating as a master, the boiler provides a control method using a PID algorithm to regulate water temperature. This algorithm allows a single boiler (Master), or multiple (Master + Member) boilers.

Figure 1 Heat band



The control algorithm is based upon a Heat Band, at the center of which is the setpoint. While below the Heat Band, boilers are staged on and modulated up until the Heat Band is entered. Once in the Heat Band, modulation is used to maintain setpoint. Boilers are shut down only when the top of the Heat Band is breached. Timers are also used to prevent short cycling.

While staging the boilers on, a modulation clamp **ADVANCED SETUP: MODULAR BOILER SET: MOD MAX-LAST FIRE** is used to hold the boilers at a lower fire rate until the last boiler is fired. Once the last boiler fires, the modulation clamp is removed and all boilers are allowed to fire above this clamped percentage up to 100%. This "boiler efficiency" clamp is defaulted to 70% and thus limits all of the boilers individual outputs to 70% until the last boiler fires. All running boilers modulate up and down together, always at the same modulation rate. As a general rule, this percentage should be no lower than twice the minimum turndown to minimize short cycling.

When additional boilers are needed to achieve setpoint in the system, the Master boiler employs an ADAPTIVE MODULATION algorithm to prevent over firing of the system. The Master communicates over the H-Net to view the exact status of each Member boiler. When a new boiler is added, the Master boiler adjusts the system modulation rate lower to compensate for the BTUs that will be introduced by the newly added boiler. This adjustment occurs when the newly added Member boiler enters its ON CALL state (default setting). This can be changed to PILOT when the new boiler is called using the menu: **ADVANCED SETUP:ADAPTIVE MOD:DROP DOWN.** Once the Main Valve (on the newly added boiler) is opened, and the **DELAY RELEASE** timer equals zero, the PID algorithm is allowed to control the system modulation. **Setting** the DELAY RELEASE timer will allow some "soak" time of the newly added boiler before releasing modulation control to the PID.

NOTICE The ADAPTIVE MOD menus are disabled on a Member boiler, but are still visible.

Member

If a "SYS/DHW HEADER" sensor is **not** connected to J10, a boiler always defaults to the role of Member.

The Member boiler can operate as part of a multi-boiler system or as a stand-alone unit.

In a multi-boiler system the Member typically receives its command signals from a designated Master-boiler. It is also capable of receiving inputs from an external control system. The boiler responds to these signals, to start/stop the burner, and/or to modulate the firing rate. The outlet water temperature is also monitored. If the outlet temperature approaches the operating limit temperature setpoint (adjustable), the boilers firing rate is limited and its modulation value is reduced to minimize short-cycling. If the operating limit is exceeded, or if an interlock trips, the boiler is shut down. When connected with a network cable, in a Master/Member role, the Members' status is interrogated by the Master boiler.

In a stand-alone installation the Member typically receives its command signals internally and operates based upon the outlet water temperature input and the established settings in the menu (Local Set-point) to start/stop the burner, and/or to modulate the firing rate. If the operating limit is exceeded, or if an interlock trips, the boiler is shut down. As in a multi-boiler system, a stand-alone Member boiler is also capable of receiving inputs from an external control system.

When using the H-Net network cable in a Master/Member system, the system setpoint is sent from the Master as a digital signal, along with the modulation value to control firing rate. It also receives its command to start or stop over the H-Net cable. Also, the SYSTEM CLOCK only needs to be set on the MASTER. The Master will then set the time on all member boilers.

If not using the H-Net protocol (cable), an external control can send a 4-20ma signal along with a 4-20ma enable signal to control the firing rate or setpoint. The boiler may also be treated as a 2-stage boiler or an ON-OFF boiler using the dedicated T-inputs.

Features & Specifications

Features Overview

Hardware Version 1.x Control (Identified by circuit board color: BLUE)

1. Five levels of external control inputs, including modulation and staging that provide application flexibility.
2. Digital Communications Control (analog 4-20ma and 0-10vdc control supported, but not required).
   a. Boiler to Boiler : HeatNet (H-Net)
   b. **B**uilding **M**anagement **S**ystem (MODBUS, Optional BACnet or LonWorks) to Boiler
3. Distributed control using the HeatNet (H-Net) protocol for up to 16 boilers. Eliminates the need for "wall mounted" controls.
4. Analog Control 4-20ma and 0-10vdc (20mA minimum current) signals supported.
5. System/Boiler operating status text display
6. Interlock, Event, and System logging with a time stamp.
7. Advanced PID algorithm optimized for the KN-Series boilers.
8. (4) Dedicated temperature sensor inputs for: Outside Air Temperature, Supply (Boiler Outlet) Temperature, Return (Boiler Inlet) Temperature, and Header (Common System Supply) Temperature.
9. Automatically detects the optional temperature sensors on power up.
10. Menu driven calibration and setup menus with a bright (Adj.) 4 line Vacuum Fluorescent Display.
11. (8) Dedicated 24vac interlock monitors, and 8 dedicated 120vac system monitors used for diagnostics and providing feedback of faults and system status.
12. Multiple circulator pump control modes.
13. Combustion Air Damper control with proof time, support for a common combustion air damper.
14. USB/RS485 network plug-in to allow firmware updates or custom configurations.
15. Optional BACnet or LonWorks interface.
16. Alarm Relay dry contacts, and Audible Alarm.
17. Runtime hours, and Cycles(based on Main Valve Open).
18. Outdoor Air Reset with programmable setpoint and ratio.
19. Time of Day clock to provide up to (4) night setback temperatures.
20. Failsafe mode when a Building Management System is controlling setpoint. If communications is lost, the boiler/system automatically transfers to local boiler setpoint control.
21. Rotation Methods(Lead-Lag): True Rotation (based on boiler runtime)is default. First On First Off (FOFO), Last On First Off (LOFO) and MIXED are optional.
22. Programmable password protection to secure the programmable settings.
23. Remote 4-20mA setpoint control using a mapped setpoint range to the 4-20mA control signal.
24. Freeze Protection allowing automatic starting of boiler(s) using (2) Failsafe modes.
25. Adaptive Modulation. When additional boilers are called, the Master adjusts all boilers fire rates to compensate.
26. Mixed boiler types in a system.

Hardware Version 2.x Control *Additional* Features (Identified by circuit board color: GREEN)

1. Support for Domestic Hot Water (DHW) using a 10k Sensor or a dry contact input from a tank thermostat.
2. Domestic Hot Water relay for use with a pump or valve.
3. On-board power and socket for Protocessor BACnet/LonWorks module.
4. HI/LO relay control option from connector J4
5. Resettable Fused interlock power circuit.
6. Additional terminal connector for H-Net shielded cable.
7. Backwards compatible to Version 1.x hardware.
8. Communications board integrated with the main board from version 1.x control.
9. Base Loading of (1) boiler.

Specifications

Control	Microprocessor based PID modulating control (**NOT a safety limit**)
Environment	-40 °F to 140 °F, <90% RH non-condensing
Input Power	24 VAC, 500 ma
Relays	System Pump, Damper, Circulator, Alarm, DHW Pump (v2.x), 8A 250 VAC resistive
	K8 on J4.2 &.6 for Base Loading version 2.x Control
AC Interlocks	24 VAC – 120 VAC input
Control Inputs	AA, Heat Demand, 4-20ma Enable, OA override, T1-T2 (dry contact inputs)
	4-20mA, 0-10 VDC (20mA source current)
Dimensions	9” wide: 6” high : 2” deep
Temperature Sensors	NTC thermistor, 10K @ 77 °F, 335.67K @ -40 °F, 185 @ 150 °F ,+/- 1 °F
USB	1.0
RS485 MODBUS	Modbus RTU
Boiler-to-Boiler	HeatNet (H-Net)
Network	Optional LonWorks, BACnet available bridge to MODBUS port

Components & Accessories

Part Number	Component
02-4277	KN-Series Control Board Version 1.x
16-0038	KN-Series Control Board Version 2.x
02-4279	RS485 Communications Board
02-4278	Graphics Display Board
02-3926	Temperature probe (bullet type, 1x.250 inch) ACI/10K-CP-BP
02-4283	Supply, Header, Return Sensors ACI 10k-CP-I-NW
02-4285	Sensor with well ACI CP-I-2.5”
02-4286	Sensor with well ACI CP-I-4”
02-4281	Strap-on sensor ACI 10k-CP-S
02-4280	Outside Air Sensor with Housing ACI 10k-CP-O
42-9529	Installation & Operation Manual
40-5409	RJ45 Communications Cable Assembly, 25 feet
40-5411	Ribbon Cable Assembly (Display Control)
58-1833	10k ohm Calibration Resistor
40-5408	USB Cable Assembly, 6ft
60-5631	Terminal Block Screwdriver
Contact Factory	MODBUS to BACnet bridge
Contact Factory	MODBUS to LonWorks bridge

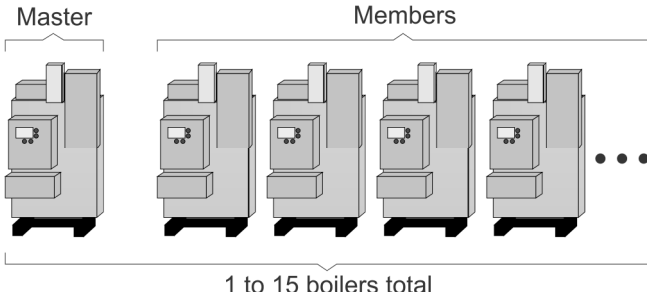
SETUP & OPERATION

Basic Multi Boiler System Operation

NOTICE For boiler system setup/installations please refer to Refer to the *2008 ASHRAE Handbook, CH12* or later revision.

A basic multi boiler system typically uses boilers of the same size and type. With HeatNet, this includes (1) Master and (1-15) Member boilers. The boilers are connected together using an H-Net communications cable effectively creating (1) boiler. This allows the system heating BTUs to be evenly distributed amongst all of the boilers. (See: Figure 41, Typical Single Boiler System, page 46).

Figure 2 Basic multiple boiler system



A basic multi boiler system can be configured using the boiler menus to create custom systems/features. These features are best described in the section: ***Default Settings & Menu Item Description,*** page 52**. Along with these menu items are hardware support for many auxiliary functions.**

Once the system has been properly setup (all default menu values used and H-Net addresses assigned), the system is enabled by placing the REMOTE/LOCAL switch to the LOCAL position on the Master boiler. All Member boilers must have their respective switches in the REMOTE position. When the Master boiler's Heat Demand input (LOCAL switch) closes, the system becomes operational and will fire as many boilers as it needs to maintain the header water temperature's setpoint.

When a boiler is to be fired in a multi boiler system (header water temperature is below the heating band), the Master checks the HeatNet boilers it has available. Then the Master checks if a Lead Boiler is to be used (LEAD BOILER > 0). The Master boiler then looks at which type of firing rotation it has selected: LOFO, FOFO, TRUE (runtime), or MIXED. In our example we will use the TRUE (runtime) rotation since it is the default.

The Master now checks all of the runtimes to determine which boiler has the least runtime based on the MIN RUNTIME setting in ADVANCED SETUP:FIRING MODE:. The MIN RUNTIME setting is the minimum runtime interval in hours that is used to compare boiler to boiler runtimes.

Once the boiler to fire has been determined, the Master sends the command over the H-Net cable to fire that boiler and resets the ADD BOILER delay timer to prepare for the next boiler to fire. If the header water temperature is still below the heating band and the ADD BOILER delay timer has expired to zero, the process is repeated until the header water temperature enters the heating band.

When a boiler receives a command to fire it:

1. The system pump relay is enabled and the H-Net control displays 'Flow Wait' until the flow-switch closes between J11A, 1 & 2 within the programmed time (10-240 seconds).
2. All elements in the interlock string, terminated between J11A and J11B, must be closed before the sequence is allowed to continue.
3. If all interlocks are closed relay K5 is enabled to command the combustion-air damper open (If used). The H-Net control displays 'Damp: Wait' until the damper endswitch to closes.
4. Relay K6 is enabled energizing the local pump (if used). The H-Net control commences its 'Flow-Wait' timer (adjustable 10–240 sec.). The flow switch contact is interrogated on terminals J11-B 5 and 6.
5. With all the interlocks closed the boiler start relay K1 is enabled and energizes terminal 6 on the ignition control.
6. The ignition control begins its cycle and provides an output signal from terminal 4 to the H-Net control. The H-Net control responds and provides an output signal to the VFD which sets the blower to the programmed pre-purge speed.
7. After air-flow is established the ignition control waits for the air switch to close. When the air switch closes it provides an input to terminal 7 and pre-purge timing commences. The H-Net display indicates 'Pre Purge'.
8. When purge is complete the ignition control energizes the pilot gas valve from terminal 8, and the spark generator from terminal 10, beginning a 10-second pilot flame establishing period (PFEP). The H-Net control responds and provides an output signal to the VFD which sets the blower to the programmed ignition speed. The H-Net display indicates 'Pilot'.
9. At the end of the PFEP the spark generator is de-energized. If the pilot flame is detected, by the UV scanner, the ignition control energizes the main gas valve from terminal 9. The H-Net display indicates 'Run'.
10. If main-flame is detected the H-Net control holds the burner at the low-fire rate for the MODULATION DELAY time period. After this timer expires, the PID allows the boiler to modulate and places the boiler into the running state.

As boilers are added to the system settings in the **ADVANCED SETUP:ADAPTIVE MOD:DROP DOWN** menu determines when the modulation rate drops down to compensate for the newly added BTUs. For the drop down to be active one boiler needs to be running when a new boiler is added (see: *Introduction: The KN-SERIES H-Net Control: Master*).

If all boilers are firing, the modulation rate is released to go to 100%. If all boilers are not firing, the modulation is limited to the MOD-MAX clamp value. The MOD-MAX clamp is used to keep the boilers running as efficiently as possible. The following *Mixed Boiler System Operation: Selecting Mixed Boilers* section outlines this with examples.

Once the header water temperature is in the heating band, only the modulation rate is used to achieve the target setpoint. The system will maintain the setpoint until the load demand increases or decreases.

As the load decreases, the header water temperature will start approaching the top of the band. The PID now lowers the modulation rate to the boilers, attempting to keep the temperature within the heating band. If the system is delivering too many BTUs, the water temperature will cross the top of the heating band.

When the header water temperature first exceeds the top of the heating band, the boilers are again checked for the one with the most runtime. The selected boiler will turn off immediately and a shed boiler delay timer will be loaded with the delay time. This time will need to expire before the next boiler will be stopped, but only if the header water temperature remains above the heating band. This timer is used to allow the header water temperature to return back into the band when a boiler is stopped. When a boiler is stopped there is a fixed rate of BTUs (Min Fire) that will be removed (PID discontinuity to modulate from Min Fire to 0 BTUs on a boiler). The timer allows for this loss of BTUs.

This cycle will continue until the call for heat is satisfied or the Warm Weather Shutdown feature is enabled.

Mixed Boiler Types Using Priority Sets

Using the *Basic Multi Boiler System Operation*, a MIXED boiler Priority method may be added to control condensing, non-condensing, base load, or other boiler **SETs** in a system together. These sets compose a system which provides for optimal performance and economy. Having dedicated sets of boilers gives the system engineer a tool to create many different boiler systems.

A boiler set can be constructed by simply setting the firing Priority on each boiler (to be in a set) at the same priority. Setting all (example) condensing boilers to the highest Priority of 1, and then setting all (example) non-condensing boilers to a Priority of 2, will create (2) sets of boilers, one condensing and the other non-condensing. Once this is done, the Priority 1 set of condensing boilers will have a firing order that has a higher Priority and is independent of the other non-condensing set with the lower priority. The boiler set with the highest Priority can then be fired based on a conditional settings menu. The lower Priority set will follow.

Mixed Boiler System Operation

Starting Boilers:

When a boiler is to be fired (water temp is below the heating band), the Master checks the HeatNet boilers it has available. The Master boiler then looks at which boilers are returning Priority firing status (set on a boiler in: (ADVANCED SETUP:SYSTEM:BOILER TYPE:PRIORITY : *1*). If the Start condition for the Priority 1set is met (ADVANCED SETUP:FIRING MODE: MODE: MIXED:SET *FIRST* (*example*), the Master or Member boiler that is configured as PRIORITY 1, with the lowest runtime, will be fired *FIRST* (*example*).

As long as the start condition for Priority 1 is met, all boilers in the PRIORITY 1 set will fire based on runtime. Once all boilers in the PRIORITY 1 set have fired, the PRIORITY 2 set of boilers will fire based on runtime.

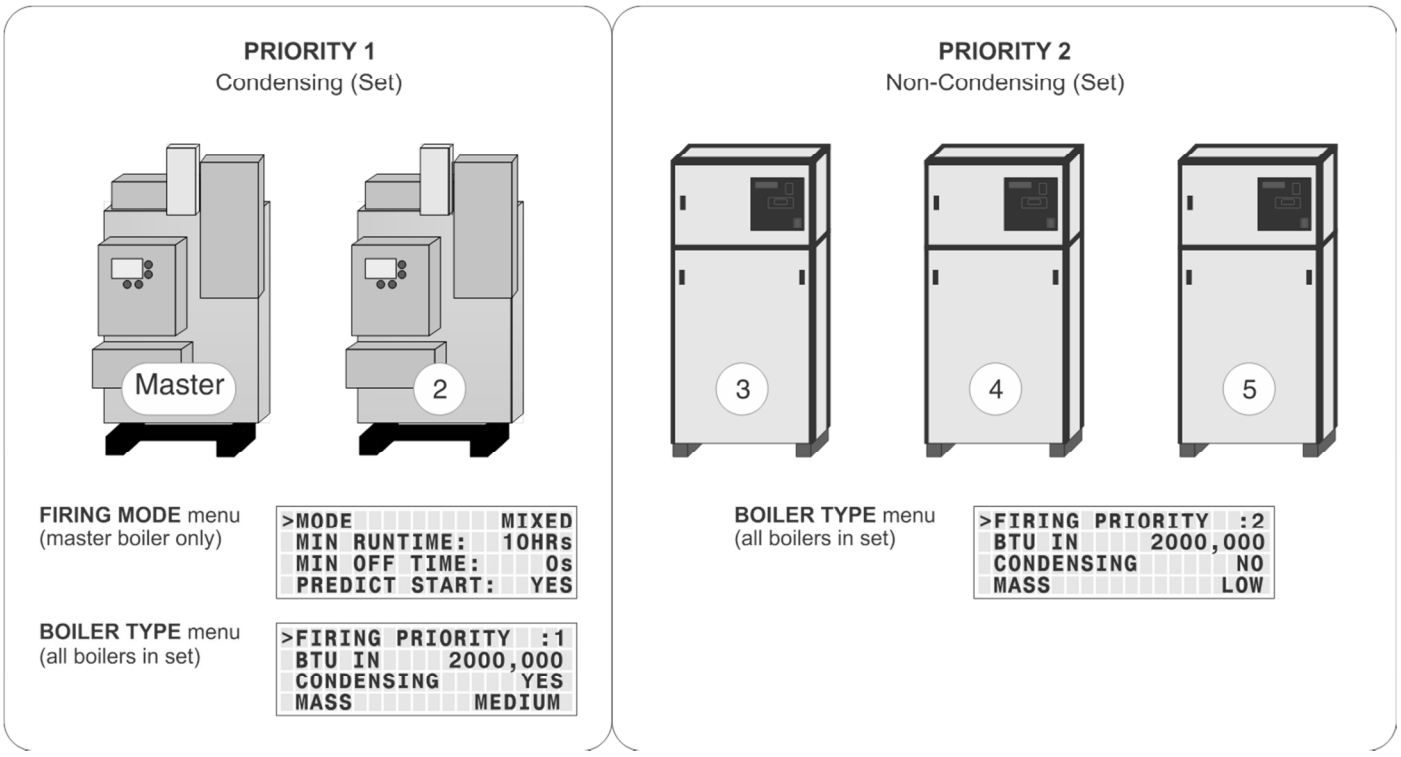
If the Start condition changes and/or is not met (such as with: OA T or RET temp), the PRIORITY 2 set of boilers will fire first/next based on runtime. This has the effect of flipping the Priority of the sets.

Stopping Boilers:

When a boiler is to be stopped (water temp is above the heating band), the Master checks the HeatNet boilers it has available. The Master boiler then looks at which boilers are returning Priority firing status (set on a boiler in: (ADVANCED SETUP:FIRING MODE: MODE: MIXED:SET *LAST*(*example*) If the Stop condition for Priority 1 is met, the Master or Member boiler that is configured as PRIORITY 1 with the highest runtime will be stopped *LAST* (*example*). As long as the stop condition and SHED DELAY time are met, all remaining PRIORITY 1 set of boilers will stop based on runtime. If the Stop condition changes and/or is not met (such as with: OA T or RET temp), the PRIORITY 2 set of boilers will stop first/next based on their highest runtime.

A boiler's firing Priority can be designated as such in: **ADVANCED SETUP:SYSTEM:BOILER TYPE:FIRING PRIORITY : 1** menu on each boiler. A Priority of '1' is the highest priority, a '2 the lowest (default is always 2).

Figure 3 Mixed Boilers: Example: Condensing/Non-Condensing



In the example *Mixed Boilers: Condensing/Non-Condensing*, condensing boilers and non-condensing boilers are used, but other combinations may also be used. Another example could use (2) small boilers and set them to Priority 1 and then use (3) larger boilers and set them to Priority 2. Using these Priority settings (with the conditions menu), the small boilers can run first during the shoulder months (Spring and Fall) and the larger boilers can fire last during the colder Winter season (base loading set).

Before the MIXED method can be used, the firing mode on the Master boiler must be set to **MIXED. ADVANCED SETUP:FIRING MODE: MODE: MIXED**. Pressing the SELECT key when the cursor is pointing to **MIXED** will enter the conditions menu. The **START** and **STOP** conditions for starting and stopping the Priority boiler set may be configured here. Temperatures are adjustable.

```
 START PRIORITY 1
>SET : FIRST
 STOP PRIORITY 1
 SET : OAT <   15°F
```

Once the conditions menu has been entered, the firing order and stop order of the Priority 1 boiler set can be selected based on up to (3) conditions in the conditional settings menu. All conditional settings apply to the Priority 1 boiler set. When the conditional settings do not apply to the Priority 1 set, the conditional settings will apply to the Priority 2 boiler set.

Start/Stop Priority Conditions

The following is an example using mixed condensing and non condensing boilers:

FIRE FIRST

Condensing boilers may be configured to **fire first** (set to PRIORITY 1) when:

1. The Return water temperature is below 140F and condensing occurs. (The Master's return water sensor would need to be moved to the header return.)
2. The Outside Air Temperature is above a setpoint determined by the system configuration. This setpoint ensures that the more efficient condensing boilers run first during shoulder months (Spring and Fall) when minimal heating is required. Below this setpoint, larger boilers should be brought on first to "base load" the system.
3. Greater efficiency is required.

STOP FIRST

Condensing boilers may be configured to **stop first** (set to PRIORITY 1) when:

The Return water temperature is above 140F and condensing is minimized, thus leaving the larger lower cost boilers running to carry the load.

1. The Outside Air Temperature is below an adjustable setpoint determined by the system configuration. This setpoint ensures that the larger non-condensing boilers run during the coldest months when maximum heating is required. Above this setpoint smaller condensing boilers should be brought on first to run the system as efficiently as possible.
2. Maximum heating is required

START PRIORITY 1 SET

Selections (always the lowest runtime first):

NOTICE The *condensing boiler set* (Priority 1) has a higher Priority to *fire* when one of these conditions is met. Values are adjustable.

FIRST: The condensing boilers (Priority 1) are always started FIRST

OA T > 15F: The condensing boilers (Priority 1) are started when the OA temperature is greater than the Mixed Boiler Outdoor Air Temperature setting.

RET < 140F: The condensing boilers (Priority 1) are started when the Return water temperature is less than the Mixed Boiler Return temperature setting (This may not applicable in most configurations since the local return temperature on the Master is used to provide a difference temperature across the heat exchanger. However, the return temperature sensor may be moved on the Master to provide system return temp if the difference temp is not required).

STOP PRIORITY 1 SET

Selections (always the highest runtime first):

NOTICE The *condensing boiler set* (Priority 1) has a higher Priority to *stop* when one of these conditions are met. Values are adjustable.

LAST: The condensing boilers (Priority 1) are always stopped LAST.

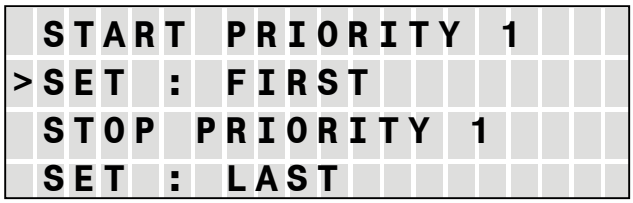
OA T < 15F: The condensing boilers (Priority 1) are stopped first when the OA temperature is less than Mixed Boiler Outdoor Air Temperature.

RET > 140F: The condensing boilers (Priority 1) are stopped first when the Return water temperature is greater than the Mixed Boiler Return temperature. (This may not applicable in most configurations since the local return temperature on the Master is used to provide a difference temperature across the heat exchanger. However, the return temperature sensor may be moved on the Master to provide system return temp if the difference temp is not required)

Start/stop settings

Any combination of Start Conditions and Stop Conditions can be used to optimize the mixing of condensing (Priority 1) and non-condensing boilers (Priority 2) for best performance/economy.

The default settings for the start and stop conditions of the condensing set are:



The default start setting always starts the condensing boilers (Priority 1 example) first, except for the lead boiler setting. The **lead boiler** will always start first if enabled, unless there is a boiler already running (this includes a Member boiler in LOCAL). The default stop condition setting always stops the condensing boilers (Priority 1) last.

If prolonging the life of the heat exchanger(s) on non-condensing boilers is very important, consider starting the condensing boilers (KN series) when the return water temperature is below 140F.

NOTICE The return water temperature sensor would need to be moved from the Master's return inlet to the system return. The **EXCHGR DELTA** may need to be adjusted in **SETUP:AUX FUNCTIONS:HEAT EXCHANGER** to prevent the Master from going to ½ input when a high **DELTA T** is reached.

This method would lead to the non-condensing boilers carrying the load when the system temperature stabilizes above 140F, since non-condensing boilers will start first with the Return water temperature is > 140F. The condensing boilers can then be stopped first when the RET water temperature is above the 140F. Remember, any combination of the Start and Stop conditions may be applied for best performance and economy in the system.

Base load boilers can also be mixed in the same way as condensing and non-condensing boilers. The base load boiler(s) can be prioritized in one set (example, Priority 2) and non-base load boilers (Priority 1) . The non-base load boilers can then be set to fire first and once they are all firing, the base load boiler would fire.

To minimize the cycling of a large base load boiler, consider using the stop condition. Change it to the OA T < 15F (Outside Air Temperature) condition. This setting may be used to stop the Priority 1 boiler set when the OA T drops below the OA T setpoint, thus leaving the large base loaded boiler on and shutting off the condensing boilers first. This is also true when using the OA T setting to start the Priority 1 boiler set when the OA T is above the start setpoint. To use temperatures as start and stop conditions, the system design temperatures must be known.

Selecting Mixed Boilers

There are a few factors to consider when choosing which type of boilers to use in a mixed system. These factors need to be considered when boilers are added or shed. When BTUs are introduced into the system by adding boilers, the amount of introduced BTUs should be smooth (linear). If these factors are not considered, discontinuity in BTUs may occur when boilers are added and as a result, short cycling will occur.

1. **Turndown**: This is the ratio of minimum fire rate to maximum fire rate: Example: a 20% minimum modulation = 5:1 turndown (100%mod / 20% mod). A (1) million BTU boiler = 200,000 BTUs minimum input.
2. **MOD MAX CLAMP**: This value determines the maximum modulation % at which the boilers will fire to until all available boilers are firing.
3. **Total System BTUs**.
4. **Desired Effective Turndown**. This is the lowest firing rate of the system relative to the maximum firing rate of the system. The larger the value, the lower the BTUs that can be delivered to a light load.
5. **Piping**.

Mixed System Type 1: High System Turndown

The following examples are of mixed boiler systems with high effective system turndown and fault tolerance built in. When boiler types are the same, the system turndown is limited to the boiler's min input and fault tolerance is always present. When the system has mixed boiler types, consideration needs to be taken on what types can be mixed properly to achieve a high system turndown and provide some fault tolerance.

Fault tolerance allows for one boiler in the Priority 1 system to fail and any boiler(s) in the Priority 2 system to fail and still provide near linear (continuity) BTU response when adding boilers. This is illustrated in the following examples using the Boiler System Response graphs.

The KN Mixed Boiler System (examples) is advantageous in providing low BTU input for light loads and high BTUs for heavy loads. The effective system turndown minimizes short cycling when light loads are present by assigning smaller boilers to Priority 1, running them first, and then stopping them last.

NOTICE In order to achieve the high effective turndown, smaller boilers are required (plumbing considerations need to be considered here due to differing flow/volume characteristics through the large and small boilers).

Example Systems:

Figure 4 Non-Mixed Boiler System

System MMBTU	Effective Turndown	MOD MAX	MB/MW 4:1
10.0	25:1	70%	KN20, KN20, KN20, KN20, KN20
5.0	25:1	70%	KN10, KN10, KN10, KN10, KN10
3.0	25:1	70%	500, 500, 500, 500, 500

With the traditional Non-Mixed boiler system, the effective turndown increases by the turndown ratio for every boiler added. The min fire rate is equal to the minimum BTUs that can be delivered to the system.

Number of boilers * Turndown Ratio = Effective System Turndown: 5 * 5:1 = 25:1.

Figure 5 Mixed Boiler System

System MMBTU	Effective Turndown	MOD MAX	Priority 1 5:1	Priority 2 4:1
4.2	35:1	60%	KN6, KN6	KN10, KN10, KN10
3.8	42:1	70%	KN4, KN4	KN10, KN10, KN10
2.2	55:1	81%	KN2, KN2	KN6, KN6, KN6
3.6	90:1	72%	KN2, KN2, KN2	KN10, KN10, KN10

With the mixed boiler system, a lower minimum fire rate/BTU can be delivered to the system by using small boilers with larger boilers. This works in much the same way as base loading.

Figure 6 KN Boiler Btu Chart (MBH)

	KN2	KN4	KN6	KN10	KN20	KN30
Max Input	200M	400M	600M	1MM	2MM	3MM
Min Input 5:1	**40M**	**80M**	**120M**	**200M**	**400M**	**600M**
Mod Max 80%	160M	320M	480M	800M	1.6MM	2.4MM
Mod Max 70%	140M	280M	420M	700M	1.4MM	2.1MM
Mod Max 60%	120M	240M	360M	600M	1.2MM	1.8MM
Mod Max 50%	100M	200M	300M	500M	1MM	1.5MM

When selecting the **Priority 1** boiler(s) for a high effective system turndown, the BTU Min Input is selected first. (See: *KN Fusion & Boiler Btu Chart*). Next, the MOD-MAX value of this Priority 1 boiler needs to be greater than**: Mod MAX % =**

(Priority 1 's Min Input + Priority 2 's Min Input)
Max Input of the Priority 1 boiler

The reason for this is keep the continuity of BTUs linear without a BTU bump (discontinuity) when boilers are added or shed. This is illustrated in the *Boiler System Response 2* graph.

If redundancy is not required, the min inputs of the Priority 1 boilers may be summed to lower the Mod Max % value so smaller Priority 1 boilers can be used. The sum of the min inputs would then need to be divided by the sum of the Max Input of the Priority 1 boilers. The effect of this would create a higher turndown. See: *EXCEPTION NOTES:*

Mod MAX % =

(((Priority 1 Min) * (#Priority 1's)) + Priority 2 Min)
Max Input of Priority 1 boiler * (#Priority 1's)

Example: (2) KN6s, (2) KN20s
Redundancy: (120 + 400)/600 = 87%
No Redundancy: (120 * 2) + 400)/(600*2) =54%

EXCEPTION NOTES:

1. Mixing more than two different size/type boilers becomes more complex than the scope of this manual and is not recommended.

2. If using more than one Priority 1 boiler and the calculated value is <

   Priority 1Min * 2
   Priority 1 Max Input

   Use this result PLUS note 3 value as the ModMax%.

3. Always add a few % (3-5%) to the calculated MOD MAX % value to allow a guard band (tolerance).

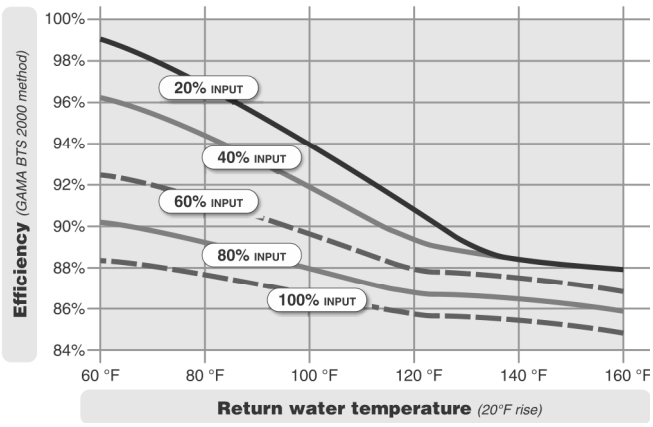
4. If boilers are of different sizes, try to use larger Priority 2 boilers.

   If the calculated Mod MAX % value is greater than 99%, the combination cannot be used since short cycling will occur.

Once the Priority 1 and Priority 2 boilers are selected, they can be multiplied in each Priority set to achieve the desired system design BTUs. If the # of boilers becomes a large number, a Priority 1 boiler with a higher Min Input may need to be selected.

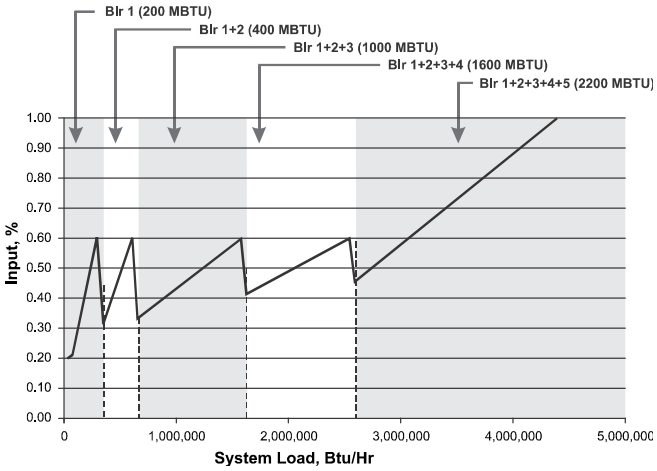
While considering the MOD-MAX value, the lower the MOD-MAX the greater the combustion efficiency since it effectively limits the input rate. The Typical Efficiency of Non-Condensing Boilers chart can help illustrate how the MOD-MAX value can affect the efficiency by limiting the input until all boilers have fired. Non-condensing boiler efficiency is relatively flat compared with condensing as illustrated in the Typical Efficiency of Condensing Boiler graph.

Figure 7 Typical efficiency of condensing boilers (GAMA BTS2000 method)



In the Mixed Boiler System table (line 1), KN6s are set as Priority 1 and KN10's set as Priority 2. With a MOD MAX of 60%, each KN6 can run to 360M (720M total) before a KN10 is called ON (Add Delay timer set long enough). Once both KN6s are running and the KN10 is then called on and running, all (3) boilers will drop to a total of the 720M BTUs: The sum of the KN6, KN6, and KN10. About 33% modulation: (.33* 600M) + (.33* 600M) + (.33* 1MM) or: 198M +198M + 330M = 726M and operate at higher combustion efficiencies. 33% is roughly between the top two lines on the Typical Efficiency of Condensing Boilers chart.

Figure 8 Boiler System Response 1
(2) KN2s, (3) KN6s



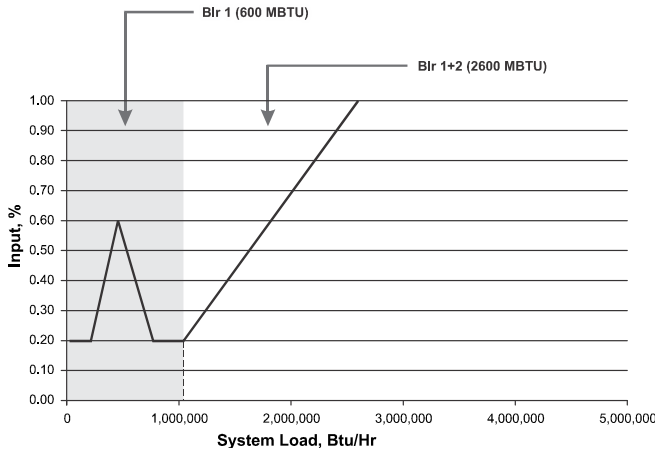
NOTICE When running non condensing boilers at low input rates, the risk of condensing should be considered.

The *Boiler System Response 1* chart illustrates how each boiler (in the example) is brought on and fires to 60%, drops to a lower fire rate and then adds the next boiler (vertical dashed lines). Once all boilers are firing, the modulation is released allowing all boilers to fire to 100%. So, for the first 2500 MBTH of load, the combustion efficiency is maximized by running the boilers from low to middle input rates.

Now if a (2) boiler system (one of the KN6s & two KN20s brought offline) using (1) KN6 with (1) KN20 and MOD-MAX set to 60%, the KN6 would fire to 360 MBTUs and wait for the KN20 (*Boiler System Response 2* graph). Once the KN20 fired, the input rate would jump to 520 MBTUs, 400M (KN20 @ 20%) + the 120M (KN6 @ 20%). There would be 160 MBTUS more than needed.

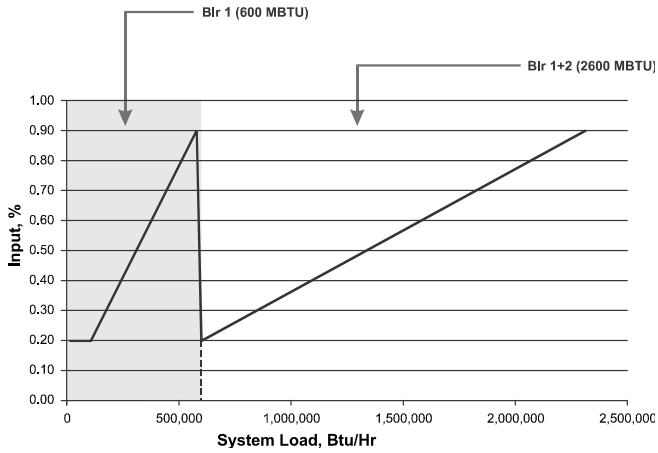
The PID algorithm would then compensate for the large discontinuity (over fire bump) in BTUs and the KN20 would shut off (short cycle). This discontinuity is observed in the graph below, (Boiler System Response 2) where the jump from the KN6 @60% to the firing of the KN20 is apparent.

Figure 9 Boiler System Response 2
(1) KN6, (1) KN20, 60% Mod-Max



To correct this would require the KN6 to set the MOD-MAX to roughly 90% (Boiler System Response 3: not as efficient as it could be) in order to have a linear BTU transfer when the KN20 is added (fired).

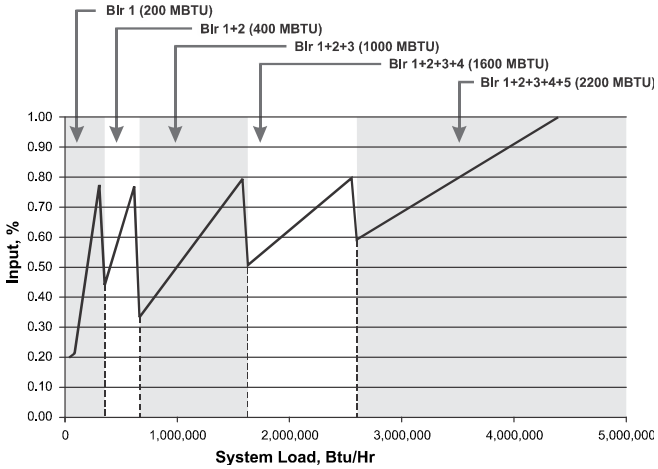
Figure 10 Boiler System Response 3
(1) KN6, (1) KN20, 90% Mod-Max



A KN6 running with a KN20 may not be an optimal choice unless (2) KN6's are always functional and used in the Priority 1 set or (3) KN6s and one is allowed to be taken offline.

A system employing this redundancy where (1) is allowed to be taken offline is listed in the MIXED BOILER SYSTEM chart. The example system uses (3) KN2s and (3) KN10s. Two of the KN2s are treated as one when adding the min inputs of the Priority 1 set.

Figure 11 Boiler System Response 4
(2) KN2s, (3) KN6s



The above Boiler System Response 4 graph illustrates another system where 80% is used as the MOD-MAX clamp.

In summary, the system should be tuned using the boiler selection charts and the MOD-MAX value so that boilers are brought on and fired in their respective efficiency curve while maintaining continuity in BTUs. Since selecting the Priority 1 boiler is integral to the fault tolerance of the system, it is important to note any discontinuities in BTUs if a Priority 1 boiler fails when multiple Priority 1 boilers are used.

Mixed System Type 2: Condensing / Non-Condensing

This mixed system may also have mixed boilers with differing sizes as outlined in the Mixed System Type 1: High System Turndown section. In the following examples condensing high mass boilers will be used with non-condensing low mass boilers. The reason for creating a mixed system is primarily to control the system cost.

For the examples, the RBI FIII series water heaters will be used. These boilers are non-Condensing, fully modulating, low mass, and HeatNet compatible. Also, consider the SMITH series 28 with the HeatNet option in the Priority 2 set.

Figure 12 Mixed Boiler System

System MMBTU	Effective Turndown	MOD MAX	Priority 1 KN 5:1	Priority 2 MB/MW 3:1
3.45	28:01:00	62%	KN6, KN6	FIII 750, 750, 750
4.2	35:01:00	76%	KN6, KN6	FIII 1000, 1000, 1000
2.3	29:01:00	62%	KN4, KN4	FIII 500, 500, 500

Figure 13 Mixed Boilers: Example: Condensing/Non-Condensing

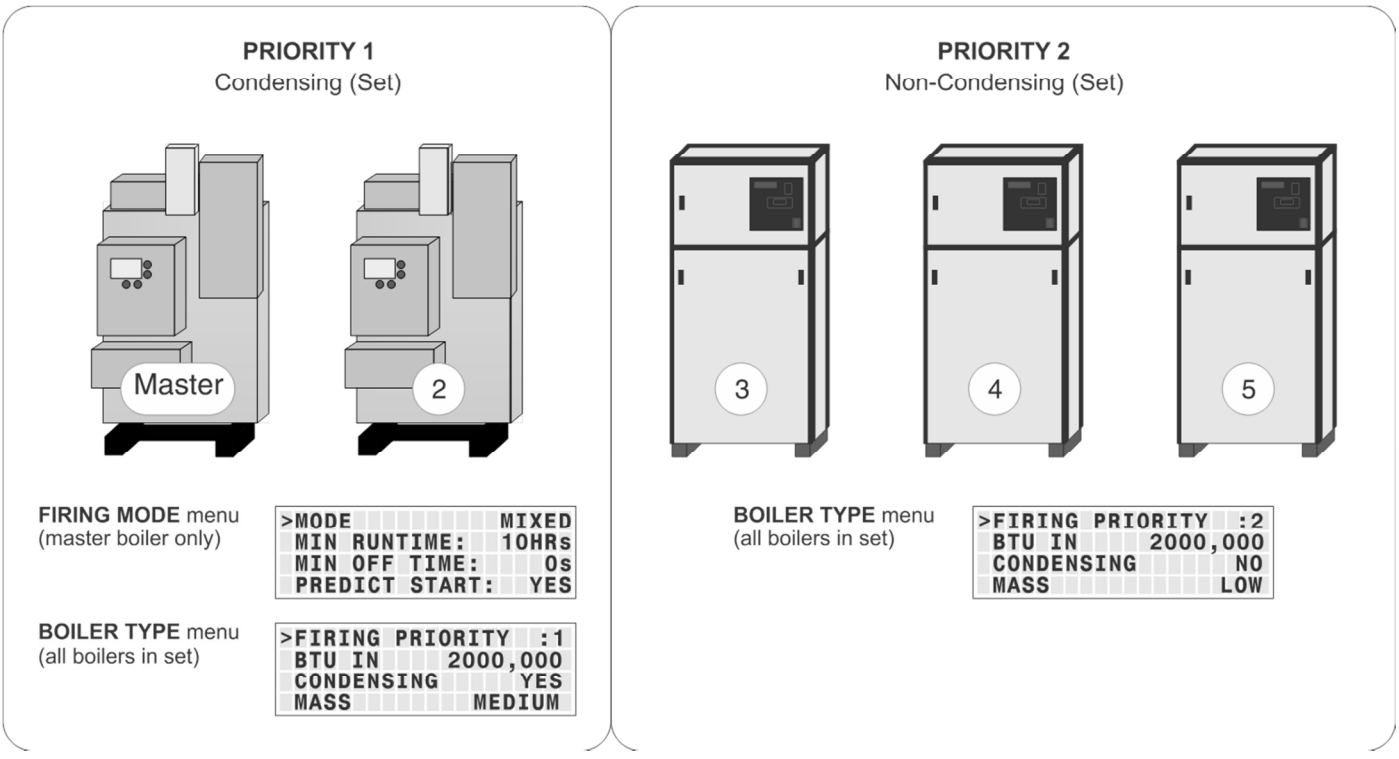


Figure 14 FIII Boiler Btu Chart (MBH)

MB/MW	500	750	1000	1250	1500	1750
Max Input	500	750	1M	1.25M	1.5M	1.75M
Min Input 3:1	**166**	**250**	**333**	**416**	**500**	**583**
Mod Max 80%	400	600	800	1	1.2M	1.4M
Mod Max 70%	350	525	700	875	1.1M	1.2M
Mod Max 60%	300	450	600	750	900	1.1M
Mod Max 50%	250	375	500	625	750	875M

Using the boiler charts and the examples used in: Mixed System Type 1: High System Turndown, a mixed hybrid boiler system can be designed. The Priority 1 boilers should be setup so as to keep the non-condensing boilers from seeing return water temperatures of less than 140F to ensure a long heat exchanger life.

Since the FIII boiler is non-condensing the efficiency vs. input is relatively flat. The MOD MAX value will not have the same impact if the FIII non-condensing boilers were placed in the Priority 1 set.

Figure 15 KN Boiler Btu Chart (MBH)

	KN2	KN4	KN6	KN10	KN20	KN30
Max Input	200	400	600	1MM	2M	3M
Min Input 5:1	**40**	**80**	**120**	**200M**	**400**	**600**
Mod Max 80%	160	320	480	800M	1.6M	2.4M
Mod Max 70%	140	280	420	700M	1.4M	2.1M
Mod Max 60%	120	240	360	600M	1.2M	1.8M
Mod Max 50%	100	200	300	500	1M	1.5M

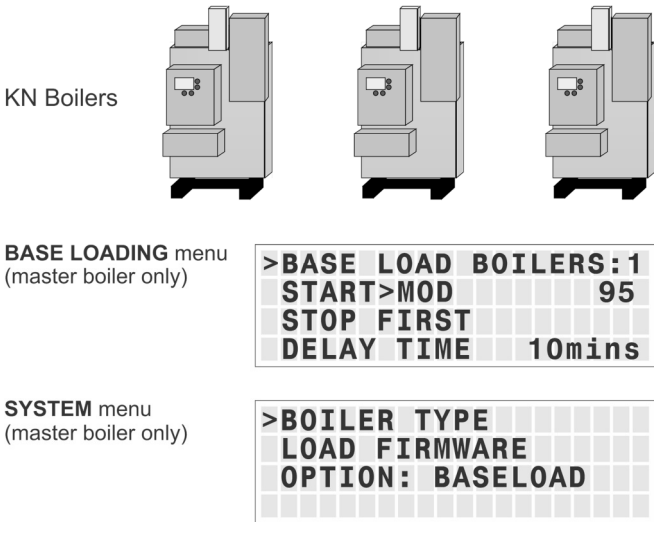
Base Loading, Relay Control

(Version 2.x control)

The control has the ability to control (1) base load boiler using the K8 Relay contacts on J4 pins 2 & 6. In order to connect to this plug, (2) wires with pins are required and inserted in J4. Base Loading via relay requires these (2) flying leads (loose wires available from the factory) to be inserted into J4, pins 2 & 6. These (2) wires then make up the Normally Open contacts. This feature also requires a rev 2.x control board and can be used on Master or Member boilers. It is not applicable in version 1.x control boards (no relay). The solid state relay K8, with contact connections on J4.2 & J4.6 has a rating of: **0.1 to 1 Amp**.

If the base load boiler is of the modulating type, a 4-20mA signal is also provided on J4 pins 1 and 5. Jumper shunt J18 will then need to be set to 4-20mA position. Two additional wires (available from the factory) will need to be added to the J4 pins at 1 & 5. Pin 1 is the + output of the 4-20mA transmitter, and pin 5 is the – output. This modulating control signal is used to modulate the base load boiler along with the HeatNet boilers in parallel. The ADAPTIVE MOD does not function in lowering the modulation rate when the base load boiler is added. The PID will adapt to the newly fired base load boiler and lower its modulation rate when the increase in water temperature is observed.

Figure 16 Base loading with KN boilers



Enable the base load feature by setting:

ADVANCED SETUP:SYSTEM:OPTION to **BASE LOAD**. This setting the OPTION Relay to be used as control for a Base Load Boiler.

1. **ADVANCED SETUP:SYSTEM:OPTION** to **BASE LOAD**. This setting the OPTION Relay to be used as control for a Base Load Boiler.
2. The **ADVANCED SETUP:BASE LOAD BOILERS: BASE LOAD BOILERS**: to 1. Currently allows (1) base load boiler.
3. The **START & STOP** qualifier condition to the method discussed below.
4. The **DELAY TIME** to the amount of time required after the start qualifier condition has been met to start the boiler.

If a MINIMUM OFF time of the Base Load boiler is needed, the Base Load boiler will share the MIN OFF TIME of the boiler controlling it. If the base load boiler was running and shuts off, the MIN OFF TIME will need to expire before the boiler can start again. Once this time expires, the DELAY TIME also needs to expire to start the boiler. This will help in minimizing short cycle conditions and can be set at: **ADVANCED SETUP:FIRING MODE: MODE:MIN OFF TIME**.

Preferred:

A modulating base load boiler that can accept a 4-20mA control signal such as the SMITH 28 series is preferred or a non-modulating base load boiler that is sized correctly to the H-Net boilers. The Smith 28 series also has a HeatNet option. A 135 ohm input for the base load boiler will need a converter from 4-20mA to 135 ohm.

http://www.smithboiler.com/

If the base load boiler is not of the modulating type, stopping the Base Load boiler will require that the size of the Base Load boiler in BTUs is known relative to the HeatNet boilers. Boiler selection is ideally; having more total BTUs in the HeatNet boilers than total BTUs of the Base Load boiler. This will prevent short cycling. Example: (4) 2 million BTU HeatNet boilers = 8 million BTUs and (1) 6 million BTU Base Load boiler.

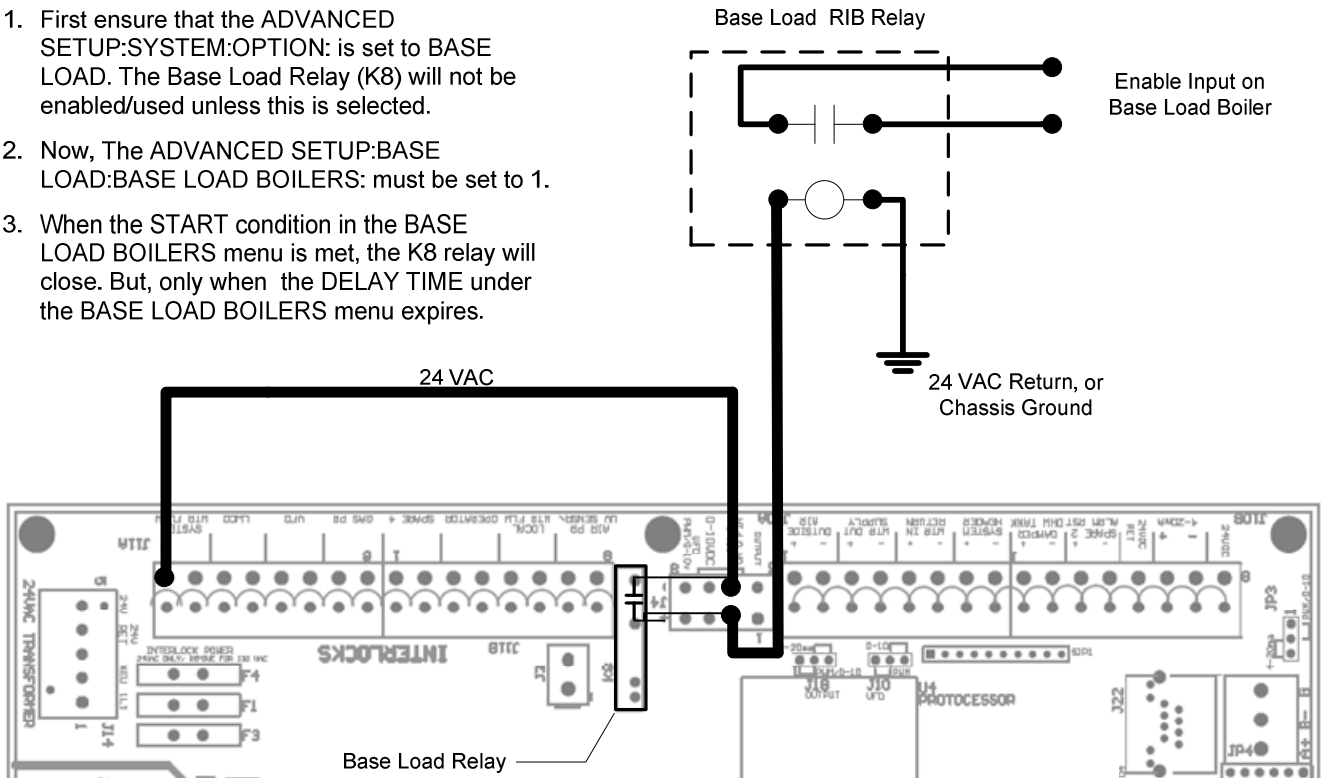
When all (4) HeatNet boilers are running @ 95%, the Base Load boiler is called on (demand is approx. 8 million BTUs). As the Base load boiler comes on it introduces 6 million BTUs and the HeatNet boilers modulate down to 25% for a total output of 2 million BTUs and running at high efficiency. The HeatNet boilers can now modulate to the load from 1.6 million BTUs (20% mod) to another 8 million BTUs.

Not Preferred:

Example of having a larger Base Load boiler that is not of the modulating type: If there is a 6 Million BTU Base Load boiler running with (3) 2 million BTU HeatNet boilers, a short cycling situation will arise when the (3) 2 million BTU boilers are running @ 95% and the Base Load boiler is called on. At this point there is a need for approximately 6 million BTUs. The (3) smaller boilers will then modulate down to low fire. At this point, the (3) smaller boilers need to shut off or the Base load boiler needs to shut off. There is no overlap. A selection for stopping the boiler now needs to be determined. Setting the Stop qualifier; Modulation to 40% or a low fire rate will shut the Base Load boiler off and allow the (3) smaller boilers to modulate up again (short cycle of the Base Load boiler; Use the Delay Timer and Min OFF timer). The Stop qualifier; OA T > xxF may also be used if the system design temperature is known. Then let the Base Load boiler cycle off its limits, whether a 2 stage, Hi/Lo, or modulating boiler. The default setting is for the Base Load boiler to stop first once the water temperature *exceeds the top of the heating band.*

Figure 17 Base loading relay

1. First ensure that the ADVANCED SETUP:SYSTEM:OPTION: is set to BASE LOAD. The Base Load Relay (K8) will not be enabled/used unless this is selected.
2. Now, The ADVANCED SETUP:BASE LOAD:BASE LOAD BOILERS: must be set to 1.
3. When the START condition in the BASE LOAD BOILERS menu is met, the K8 relay will close. But, only when the DELAY TIME under the BASE LOAD BOILERS menu expires.



Setting up base loading

The base load boiler is controlled using a set of contacts to enable it (location J4). Enabling/Disabling this relay contact can be done using any combination of (3) qualifiers to start the boiler and (4) to stop the boiler. These qualifiers are:

1. **Modulation %**:
   a. **START menu item**: The relay contact will close when the MOD % from the Master boiler exceeds this value. **ADVANCE SETUP:BASE LOADING: START>MOD**
   b. **STOP menu item**: The relay contact will open when the MOD % from the Master boiler falls below this value. **ADVANCE SETUP:BASE LOADING: STOP<MOD**

NOTICE If the **START>MOD** value is set to a value higher than the **ADVANCED SETUP:MOD-MAX**: **all boilers** will be firing before this modulation rate is reached. This will ensure that all available boilers are firing before the base load boiler relay is enabled.

   c. Setting the : **STOP<MOD** to a % value slightly above the min fire rate % of the system will ensure that the base load boiler will stop before the first condensing boiler stops. This is due to the Modulation rate being close to the min modulation rate before the water temperature exceeds the top of the heating band.

2. **Outside Air Temperature**:
   a. **START menu item**: The relay contact will close to enable the boiler when the OA T read from the Outside Air Temperature sensor (if Equipped) falls below this temperature. **ADVANCE SETUP:BASE LOADING: START< OA T**
   b. **STOP menu item**: The relay contact will open to disable the boiler when the OA T read from the Outside Air Temperature sensor (if equipped) rises above this value. **ADVANCE SETUP:BASE LOADING: STOP> OA T**

NOTICE If the OA T qualifier is used as the Start and Stop qualifier, ensure that there is at least a few degrees difference for hysteresis.

3. **Return Water Temperature**
   a. **START menu item**: The relay contact will close to enable the boiler when the RET read from the Return Water Temperature sensor (if Equipped) falls below this temperature. **ADVANCE SETUP:BASE LOADING: START> RET**
   b. **STOP menu item**: The relay contact will open to disable the boiler when the RET temperature read from the Return Water Temperature sensor (if Equipped) rises above this temperature. **ADVANCE SETUP:BASE LOADING: STOP< RET**

4. **FIRST**:
   a. **STOP menu item**: The relay contact will open to disable the boiler when the temperature exceeds the heating band. This gives the result of stopping the Base Load boiler First. Default setting.

Delay time

The DELAY TIME is also included to hold off starting the boiler until the delay time is met. Once the start condition qualifier term is met, the DELAY TIME will start counting down. When the time expires, the base load relay contacts will close. **ADVANCE SETUP:BASE LOADING:DELAY TIME**. It is adjustable in a range of: 0 to 60 minutes.

Base Load Failsafe

If there are no boilers available to fire (offline or faulted) and there are no boilers in local override, and there is a call for heat, The J4 Base Load relay will close. If a boiler becomes available and needs to fire, the Base Load boiler will remain firing until the temperature exceeds the band. This is provided to keep the system from entering a no heat situation.

Heating Control Methods

An overview of the (5) methods for controlling the KN series boiler are presented here. They are outlined in more detail at the end of this section. See Figure 31, page 36, through Figure 37, page 42.

Heating Method 1

The first method is to use the KN Series boiler in its stand-alone modulating method. This method uses a PID algorithm to maintain a setpoint and is enabled using the HEAT DEMAND input. Closing a relay contact or switch across the HEAT DEMAND input will cause the Master boiler to control all member boilers using H-Net.

A member boiler may also be controlled by the HEAT DEMAND input (LOCAL mode). The member boiler will then ignore commands from the Master and maintain its LOCAL SETPOINT at the supply sensor.

Heating Method 2

The second method is to view the KN boiler as two separate boilers or as a HIGH/LOW boiler using T1 & T2.

Heating Method 3

The third method is to allow a remote 4-20 ma or 0-10 VDC signal to control the firing rate (modulation) of the boiler using the 4-20ma input, along with the 4-20ma REMOTE ENABLE input.

Heating Method 4

The fourth method turns the boiler ON and OFF @ 100% modulation using the AA terminal.

Heating Method 5

The fifth method uses an RS485 digital communications cable with the MODBUS protocol. The boiler is controlled by writing and reading registers using MODBUS commands. A bridge module may also be used to convert BACnet or LonWorks protocols to MODBUS.

NOTICE

Short cycling may occur when a firing rate is sent to a member boiler that would cause the supply temperature to rise high enough to trip the operating limit (low flow rate). After the supply temperature falls, the boiler would restart and the process may continue. A member boiler would use its supply (outlet) sensor to protect itself from short cycling by limiting the firing rate coming from the Master. This occurs in the event that the member's supply temperature increases above the (OPERATE LIMIT- OPERATE LIMIT BAND).

Operating Limit

When the master boiler or an external control input is used to control a member boiler (i.e. AA, T1-T2, 4-20ma, H-Net), a software operating limit on the member boiler will be used to limit the maximum output of the member boiler. This operating limit can be adjusted in the **SETUP:SETPOINTS:OPERATING LIMIT**.

There is also an associated operating limit band that must be set in conjunction with the operating limit to help prevent this LIMIT from being reached. Its purpose, is to limit the output of the boiler as it approaches the operating limit. If the band is set to 10 degrees, then for every degree that it approaches the operating limit, the maximum output will be lessened by 10%. With a band of 20 degrees, for every degree that it approaches the band, the maximum output will be lessened by 5%. You can think of this operating limit as a smart aquastat which prevents the High Limit from tripping. This method minimizes boiler short cycling when using external inputs. The minimum setting is 1 degree and effectively turns the limit band OFF. The default setting is 20F.

Input Priorities

The KN-Series **control inputs are prioritized** so that multiple levels of external control can be employed at the same time. This means that if we are firing the boiler with a low Priority input and a higher Priority input is called for, the boiler will now fire at the higher Priority input. When the high Priority input is removed, the boiler will revert back to the lower Priority input that is still being called.

Priority 1

The AA terminal has absolute control, and if used, will always fire the boiler at 100% output, regardless of any other input. The 4-20mA input may be raised to this Priority using **ADVANCED SETUP: 4-20mA INPUT:PRIORITY**.

Priority 2

The HEAT DEMAND input is the next, and provides the means to operate the boiler in LOCAL MODE when an external control is not present, has failed, or needs to be enabled or disabled. A member can override the H-Net commands using this input.

Priority 3

If a HeatNet (H-Net) Network cable is connected between boilers, and one is configured as a MASTER (requires HEADER sensor), then the MEMBER boilers will be controlled over the network by the MASTER.

Priority 4

The 4-20ma/0-10VDC input in tandem with the 4-20ma REMOTE ENABLE input is next. Any signal over 4.02ma or 2.01VDC will start and operate the boiler if the REMOTE ENABLE is closed.

Priority 5

The lowest Priority is using the boiler as (2) stages HIGH/LOW. These are the T1 and T2 inputs.

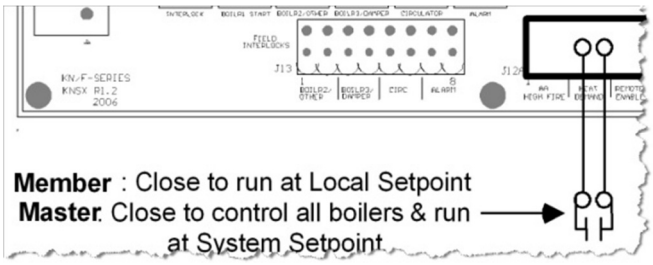
Each of these control methods will now be explained in more detail:

Heating Method 1
HEAT DEMAND

Closing a relay contact, switch, or jumper across the HEAT DEMAND input will enable this method. This method allows operation as a setpoint control. As a setpoint control, the Master (defined by having a common system supply header sensor), on the H-Net network can command the boiler fire rate of all Member boilers. The Master can call as many boilers that it has available (boilers are auto-detected over the H-Net cable by the Master) to meet its **SYSTEM SETPOINT**. The H-Net cable must be connected and will cause the amber light on the communications board to flash. The amber light indicates an H-Net master is broadcasting control information and a system heartbeat.

The AA terminal, the FAILSAFE mode active, 4-20ma at PRIORITY:HIGHEST, and the HEAT DEMAND input (LOCAL) on a Member, are the only inputs that will override the H-Net control.

Figure 18 Heat demand input



Master boiler

The MASTER boiler controls the system using a PID algorithm. Once the boiler is started, a PID algorithm is used to produce a modulation percentage value from 0-100%. This percentage is converted to a PWM, (P)ulse (W)idth (M)odulation signal by each boiler. The temperature of the water is maintained by sending this PWM signal to the Variable Frequency Drive, which in turn controls the blower motor. Since the main fuel valve is air-fuel coupled to the blower, the speed of the blower provides the firing rate.

Member boiler(s)

A Member (lacking a common system supply header sensor) boiler may also be controlled by the HEAT DEMAND input (LOCAL mode). The member boiler will then ignore commands from the Master and maintain its own LOCAL SETPOINT at its supply sensor. This can be viewed as a manual override on a member boiler. Be sure to observe the use of the proper use of a Common System Damper (See: AUXILIARY FUNCTION OPTIONS section) and any system pumps or system common interlocks.

Features of the HEAT DEMAND input include:

1. The control is designed to **predict** when to start and stop the boiler and keep the setpoint in, or as close to the control band as possible. If PREDICTIVE START is enabled, the boiler may start when it is in the band and not below it. This will help to maintain a more accurate temperature relative to the setpoint. See also: ADVANCED SETUP:FIRING MODE:PRDICTIVE START: to disable this feature.
2. The control can also use the Outdoor Reset feature. This feature allows the setpoint to be changed automatically based on the outside air temperature. If this feature is used, the control input: OR OVR (OUTDOOR RESET OVERRIDE), can be used to override the Outdoor Reset feature and run from the local setpoint. A contact closure on the ‘AA’ input can also override this method.
3. Firmware Version 2.0 added a 4-20ma setpoint control function that works in conjunction with this mode. This

function translates a 4-20ma control signal to a setpoint mapped between 50F and 220F. These (2) temperatures are adjustable to provide a setpoint range. The minimum start current is also adjustable between 3.71 and 5ma. The setpoint control feature is used in conjunction with the REMOTE ENABLE input on J12A. This feature is enabled in the SETPOINTS menu as:

SETPT SOURCE 4-20ma

4. Firmware version 2.2 added support for a common system damper, Heat Exchanger support, and starting the Master first for common venting. For an overview of each of the menu settings see: **DEFAULT SETTINGS** section.

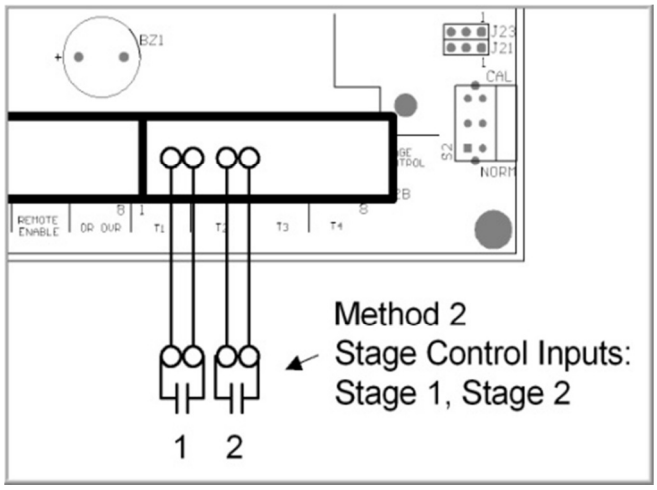
Heating Method 2 STAGE Control T1-T2

The boiler can also be operated in 2 separate stages using the inputs T1 and T2 inputs. Its intended use is with an external stage controller with no analog or modulation outputs.

Closing only one of these contacts tells the boiler to operate at MINIMUM FIRE.

1. Closing the other contact will fire the boiler at MAXIMUM output (the same rate as closing the AA input).

Figure 19 Stage control input



NOTICE The maximum output of the boiler is based on the MAX VFD setting in the calibration mode and not the nameplate rating.

The AA, HEAT DEMAND (LOCAL) input, the H-Net, the 4-20ma input will all override the stage control inputs.

Heating Method 3 4-20ma Control

Placing a current source between the + and – 4-20ma inputs will allow remote control of the boilers firing rate. An adjustable starting mA current signal here will start and then fire the boiler at the minimum fire rate. See**: ADVANCED SETUP:4-20mA INPUT**.

See section OPTIONAL FEATURES Using the 4-20ma input for extensive detail.

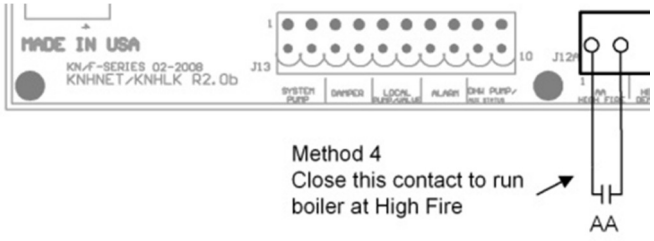
A 20ma signal will fire the boiler at the maximum firing rate. The input current signal is viewed as a percentage to the boiler from 0 to 100% (0-20mA). This means that a 20% (4mA) input signal is required to start the boiler, but since the boiler is classified as having example:4:1 turn down ratio, the boiler can only be fired as low as 25% of output. Any signal between 20% and 25 %, will fire the boiler at the minimum fire rate. If the MINIMUM setting of the boiler is set above the example: 4:1 turndown of 25% (such as 33%), a control signal change between 25% and 33% will not change the boilers firing rate. Once the control signal rises above the MINIMUM fire rate, the control signal will then affect control of the boilers fire rate.

The AA terminal, the HEAT DEMAND, and the H-Net NETWORK are the only inputs that will override the 4-20ma input.

Heating Method 4 AA Input

HIGH FIRE input Control: The AA input will fire the boiler at HIGH fire (maximum output of the boiler). No other inputs can override this input.

Figure 20 AA — High fire input



Heating Method 5
MODBUS communications

The fifth method uses an RS485 digital communications cable with the MODBUS protocol to control the boiler using the H-Net network. The Boiler or Boiler network will run as in Method 1, but instead of the HEAT DEMAND input, a software form of the HEAT DEMAND input is used (40001: Boiler/System Enable/Disable). See: MODBUS COMMUNICATIONS section.

Figure 21 MODBUS connections — version 1.x board

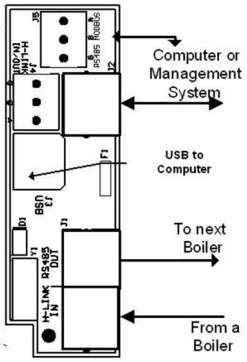
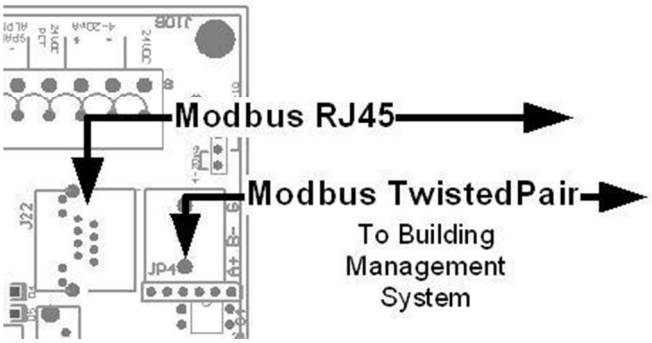


Figure 22 MODBUS connections — version 2.x board

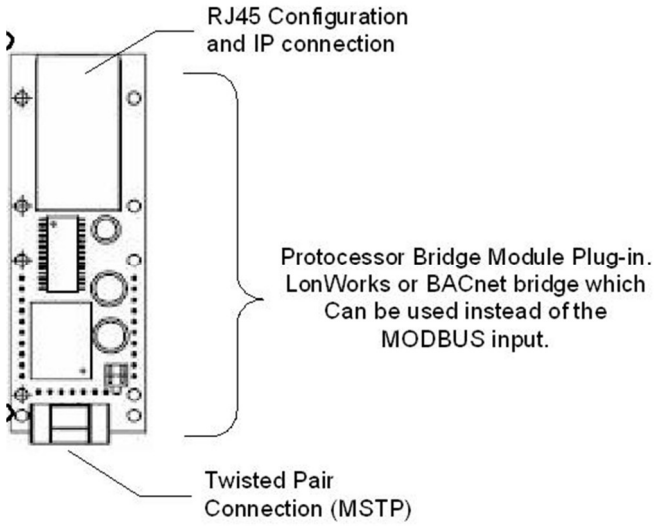


The System Setpoint Timer also needs to be loaded periodically to allow the H-Net system to fallback to Method 1 in the event communications is lost from the Building Management System (BMS). The MODBUS protocol allows writing and reading registers using MODBUS commands.

Protocessor option

An optional BACnet or LonWorks bridge module can be used to connect the MODBUS network to a BACnet or LonWorks network.

Figure 23 Protocessor bridge module option


RJ45 Configuration and IP connection
Protocessor Bridge Module Plug-in. LonWorks or BACnet bridge which Can be used instead of the MODBUS input.
Twisted Pair Connection (MSTP)

This method allows enabling and disabling the boiler or H-Net system, changing setpoints, reading boiler(s) status, or temperatures remotely using digital commands. See the section: *MODBUS Communications.*

Using the 4-20ma input *(OPTIONAL)*

The 4-20ma input is designed to operate per the ISA-50.1 standard. It will support Type 2, Type 3, and Type 4 Transmitter/Receiver circuits.

The Type 2 and Type 3 circuit may use the supplied +24VDC and 24VDC RET connections (J10B) to power a remote transmitter. The –ma terminal will need to have a jumper connected to the adjacent 24VDC RET terminal to reference the signal ground.

With the type 4 configuration, multiple boilers (up to 5), may be connected in series using the –ma +ma –ma +ma scheme (no jumper to 24VDC RET). This allows one 4-20ma transmitter to control multiple boilers. A free-floating 250 ohm resistor is viewed by the BMS (or external control's) 4-20ma transmitter across the + and –4-20ma terminals with this method.

Figure 24 4–20ma connections

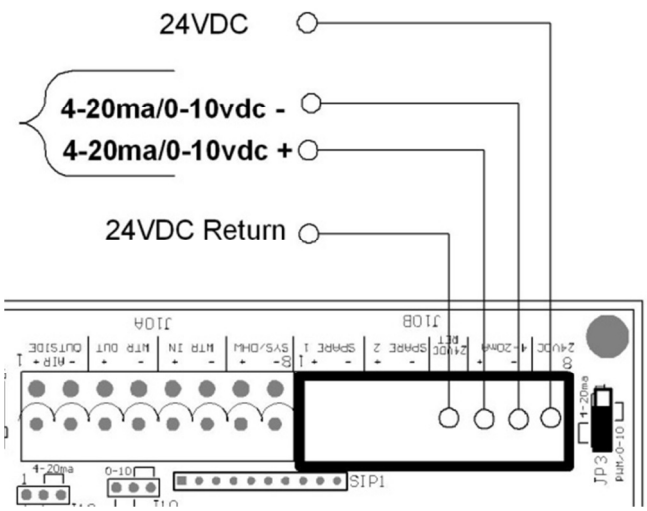
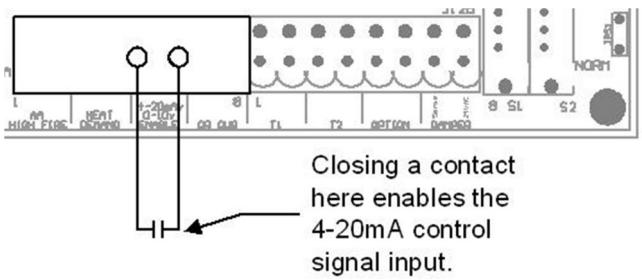


Figure 25 4–20ma enable connection



The 4-20 ma input uses a 250 ohm sense resistor to convert the current to a voltage from 1 to 5 volts DC for the control to use. For this reason, a 1-5 VDC control voltage may also be used across the 4-20mA +/- input, but it still needs to supply the necessary current, i.e. 20mA. This resistor is located on the bottom side of the control board. When a 4.02 ma signal is sensed, the boiler will initiate a start sequence and fire the boiler at its minimum setting if the REMOTE ENABLE input is closed. This is typically 25% of the boilers output (4:1 turndown).

If jumper shunt JP3 is set to the PWM/0-10 position, the 4-20mA input will accept a 0-10 VDC signal. The operating range will be from 2-10 VDC or twice what was previously stated for the 1-5 VDC functionality. **To convert a 0-10VDC signal to mA, divide by 500 (ohms).**

NOTE: Due to the inability of control voltage methods (1-5, 2-10 VDC) to reject noise, the use of the 4-20mA control current is recommended. The control voltage methods may be less expensive, but are the least stable. If using a 0-10VDC control signal, a source current of 20mA is required.

If using a remote panel with a relay and a 4-20 ma transmitter for operation, connect the 4-20ma transmitter output from the remote panel to the member boilers using the floating 250 ohm method (type 4). The relay contacts on the remote panel will then be connected to the associated 4-20ma REMOTE ENABLE inputs on the associated boiler(s).

NOTICE

The minimum setting of the boiler is calibrated so that the minimum **PWM** signal to control the Blower motor is 20%. The VFD to blower motor operates with a control signal from 20% - 80% Pulse Width Modulation. This PWM signal to the VFD can be measured using a multimeter. It is a 0–10volt square wave signal at 110 Hertz. A 20% modulation signal will read 2.0 VDC, and an 80% modulation signal will read 8.0 VDC on an RMS multimeter. See Figure 42, page 47.

Setpoint Control functionality can be implemented remotely using the 4-20mA input. This function translates a 4 to 20ma control signal to a setpoint mapped from 50F to 220F. The feature is enabled in the SETPOINTS menu as: **`SETPT SOURCE 4-20ma`**.

`ADVANCED SETUP:4-20ma INPUT`. Also, when selecting; SETUP:SETPOINTS:SETPOINT SOURCE and selecting 4-20ma, the 4-20ma INPUT menu will be automatically entered.

You may now select the current at which the boiler will start. It is adjustable from 3.7ma to 5ma. Hysteresis of .1ma is always in effect. So, if the starting ma = 4.10ma the boiler will start when the control current applied achieves this value of 4.10ma. The boiler must drop .1ma below this to turn OFF,

in this example 4.00ma. This hysteresis value is not adjustable.

When using the 4-20ma setpoint control, a band may now be set at which the 4-20ma signal will operate over. The lower setpoint is defined as 4ma SETPOINT and the upper setpoint is defined as 20ma SETPOINT. The 4ma SETPOINT is linked to the BOILER START x.xxma where this starting current is the lower setpoint. So, if we set the 4ma SETPOINT to 130F and the 20ma SETPOINT at 180F we will have established the band. Once a starting control current of BOILER START 4.1mA is applied, and the 4-20 REMOTE ENABLE INPUT is closed, the boiler will start and the setpoint will be set to 130F. If a control current of 10ma is applied the boiler will track on a linear slope towards the 20ma SETPOINT settling at a SETPOINT of ~149F. As the current increases to 20ma, the SETPOINT will indicate 180F. The Default setting is 4ma SETPOINT: 50F, and 20ma SETPOINT 220F for backwards compatibility with the older version. NOTE: anytime a new firmware version is uploaded to the control, these values return these defaults.

NOTICE Anytime a new firmware version is uploaded to the control, these values return to these defaults.

If using the direct modulation mode by applying a 4-20ma current, only the BOILER START x.xx setting applies.

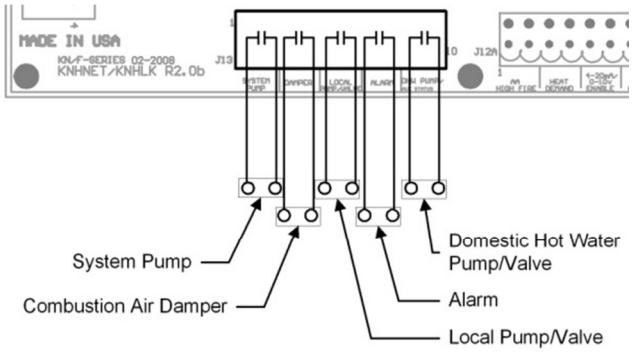
Firmware Version 3.0 adds the ability to set the 4-20 mA input to HIGH PRIORITY. This can be set in menu: **ADVANCED SETUP:4-20mA INPUT**. This allows a member boiler to be taken offline and directly modulated by an external control. If the Master is using it for heating and the 4-20mA is set to HIGH PRIORITY, an external control can now output a 4-20mA signal which will take over the boiler's fire rate. This is typically used for DHW control.

Circulator Pump Options

There are provisions for a system pump and a local pump. This is to allow for primary/secondary loop configurations. The system circulator pump is implemented using the K4 RELAY and normally open contacts at J13 BOILER 2/OTHER or marked SYSTEM PUMP depending on the revision control board.

NOTICE The pumps require motor contactors to isolate the on-board relay contacts. The on-board relays should never be used to energize pumps directly.

Figure 26 Pump connections



The **system circulator pump** is supported by (2) modes and a special feature.

1. The first mode will allow the circulator pump to remain on, unless the control's outside high air temperature setting has been met when using OUTDOOR AIR RESET.
2. The second mode will allow the circulator pump to be turned on whenever there is a call for heat (any control input). This mode will stop the circulator pump when the call for heat is lost and the pump post purge time has been satisfied.

The summer pump jog is a special feature that can be selected when the system is in summer shutdown (OUTDOOR RESET). The jog allows the system circulator pump to run for the pump purge time once a week. It can be set to any day of the week and will occur at 12:01 AM.

The system flow proving switch is implemented using SPARE 3/System Water Flow on J11A. If a flow switch is connected to the WTR FLW interlock, the HeatNet control will wait up to 240 seconds to prove flow. This time is adjustable under **SETUP:PUMP OPTIONS**. The default flow proving time is 10 seconds. It can be increased to allow

slower valves to open before flow is established. If flow is interrupted after it has been established, an error will be displayed and the boiler will cycle OFF. As long as there is a call for heat, every 10 minutes the circulator pump will try to re-establish flow and start the boiler again.

The **local circulator pump** is supported by (3) modes and (2) features.

1. The first mode allows the circulator pump to remain on, unless the control's outside high air temperature setting has been met when using Warm Weather Shutdown.

2. The second mode will allow the circulator pump to be turned on whenever there is a call for heat (any control input). This mode will stop the circulator pump when the call for heat is lost and the pump post purge time has been satisfied.

3. The third mode works much the same as mode 2, but it allows the inlet sensor (RETURN) to be used with the outlet sensor (SUPPLY) to keep the pump on until a delta (difference) temperature is met. A return temperature sensor is required for this mode, because the delta temperature (SUPPLY – RETURN) measured is across the boiler. In this mode, the post purge time is also used. After the delta temp has been met, the post purge time needs to expire before the pump is turned off. This mode works much the same as mode 2.

PUMP/VALVE OPTION: This is a special feature of the local circulator pump to prevent deadheading water flow when all boilers are off. When this feature is enabled, the master boiler will enable its local circulator pump/valve when **NO** boilers are running. If boilers are running in LOCAL override and not controlled by H-NET, but are visible to H-NET, the pump(s) on these boilers are presumed ON. In this situation, the master **will not** enable its circulator pump/valve unless it is running.

Another feature of the PUMP/VALVE OPTION is to control a local (primary) pump using a Variable Frequency Drive. This feature may be required when a secondary system pump is also variable speed. To enable this feature**: SETUP:PUMP OPTIONS:LOCAL PUMP PUMP/VALVE OPTION:LOCAL PUMP VFD: ON**. Setting this Option to ON will map the control signal on J4 pins 1+ and 5- to the modulation rate. (2) wires need to be run from J4.1+ and J4.5- to the VFD's input connection. Ensure that the J18 shunt jumper on the control board is in position PWM/0-10.

Auxiliary Function Options

Relay K5 and the terminal J13 DAMPER is used to control a combustion air damper. The Spare 1 input on J10B or J12B is used to detect the dry contact proof switch from the damper. The J12B is the preferred connection, J10B is used for backwards compatibility. A proof time of up to 4 minutes can be set before the boiler can start or an alarm condition will occur. The Combustion Damper can be setup in the **SETUP:AUX FUNCTIONS** menu.

The Master boiler controls the system damper, so in the event this damper fails to open, the system will not start. If the Master boiler's system damper fails, then no call for heat will be made to the member boiler(s).

Each member boiler can control its own damper and is independent of the Master boiler when a call for heat is made to the member. This allows for separate dampers for each member boiler. They can be wired to J12B terminals 7 and 8.

If a common system damper is used (controlled by the Master boiler), each individual boiler must prove that the combustion air damper is open when it is placed in LOCAL. This may be done using J12B terminal 7 on all boilers wired to the damper's prove switch. Terminal 7 is the sense input and terminal 8 is 24 VAC. Connecting a wire to terminal 8 is not recommended.

See Figure 43, *Common system damper wiring*, Page 48.

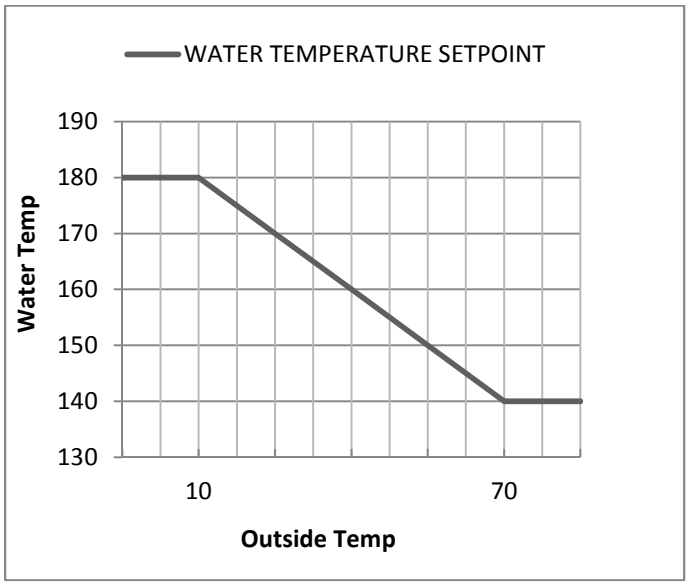
NOTICE A separate/independent 24 VAC source is recommended to be used for the damper prove switch when a common system damper is used. If you use terminal 8 to supply power from the Maste,r and the Master is powered OFF, no boiler will be allowed to fire due to the loss of power through the prove switch. A backup boiler will also need to have the damper relay contacts wired in parallel with the Master for when the Master is powered OFF.

A second wire on the Master J12B terminal 7 is then connected. The other end of this wire is then run to the first Member boiler J12B terminal 7. If another member boiler is present, a second wire can be connected to the first member boiler J12B terminal 7 and the other end connected to the other boiler J12 terminal 7. This method can be continued if additional boilers are present. This input must be selected in the **SETUP:AUX FUNCTIONS:COMBUST AIR DAMPER** menu.

Outdoor Reset

The Outdoor reset feature allows the water setpoint temperature to change dynamically with the outside air temperature. It also provides an adjustable temperature that shuts the boiler/boiler system down when the outside temperature rises above it. Firmware version 2.3 and up separates the Warm Weather Shutdown from the Outdoor Reset.

Figure 27 Outdoor reset curve, typical



The above chart shows how the water temperature setpoint changes with the Outside air temperature. The four values of 180, 10 and 140, 70 are the default values:

WATER TEMP LOW OA TEMP	180 °F 10 °F	**Water temp @ outside air temp**
WATER TEMP HIGH OA TEMP	140 °F 70 °F	Water temp @ outside air temp
WWS Setpoint	72 °F	Outside air temperature where Warm Weather Shutdown occurs
WARM WEATHER SD=ON		If set to ON here

The chart depicts what the water temperature setpoint will equal with a corresponding outside air temperature. At an outside temperature of 10F and below, the water temperature setpoint will be limited to 180F. With an outdoor temperature of 70F and above, the water temperature will be limited to 140F. The water temperature setpoint will track along the charts plotted line with corresponding outside temperatures.

The OR OVR (Outdoor Reset Override) input on J12A can be used to override this Outside Air Setpoint and maintain the water setpoint at the LOCAL or SYSTEM SETPOINT value when a contact is closed across this input. This can be used as a Domestic Hot Water demand input.

Another function of the OUTDOOR RESET is the Winter/Summer mode ((W)arm (W)eather (S)hutdown). With the WWS SETPOINT set to 72F and WARM WEATHER SD set to ON, the boiler/system will enter summer shutdown when the Outside Air temperature rises above 72F. While in this state, the OR OVR input on J12A can be used to bring the boiler/system on to maintain the water setpoint at the LOCAL or SYSTEM SETPOINT value.

During WWS operation, the System pump will not be enabled just the Local pump unless the SETUP:SYSTEM PUMP:OVR ENAB IN WWS is set to ON. This is the System Pump Priority mode. When SETUP:SYSTEM PUMP:OVR ENAB IN WWS is set to OFF, the system pump will not come on while in WWS with the OR OVR override input closed.

Sensors

The H-Net control supports a standard 10K thermistor (Type ACI/10K-CP). These sensors can be calibrated to the control by entering the sensor menu and placing a precision 10k resistor on an input.

NOTICE Immersion sensors must have wells.

Security

A password can be used to lock out control and setup features. It can be enabled, but is shipped in the disabled state.

Diagnostics

The H-Net control can display and identify faults in a meaningful way. If an interlock trips, it will be indicated in the main screen display, along with an audible alarm (mounted on control board) and a set of relay contacts will close. A record of this, with a time stamp, will also be entered into the log as an aide in the diagnosis of the event. The log can be downloaded and a histogram used to display the data. If using Modbus, BACnet, or LonWorks, software flag bits in registers are available.

Open and shorted sensors are checked continuously, so that in the event of a sensor failure, the system shuts down and the alarm relay is closed.

If a pump fails (flow switch required), or the flow switch fails, the boiler will cycle the start condition every 10 minutes in an attempt get the boiler restarted.

If the damper fails to open and never closes its proof switch, a retry algorithm will attempt a retry. Every 10 minutes the damper relay will cycle and try to open the damper again.

If the H-Net control closes the last interlock string connected to the ignition control and the ignition control never closes its Blower Relay, the H-Net control will wait 2 minutes. The H-Net control will then retry for the duration of the local pump post purge time and then retry the ignition sequence. During this time "retry strt" will be displayed in the status screen. After (5) attempts the H-Net control will lock out and display call service.

Communications

The H-Net control has the ability to communicate using the MODBUS protocol with a building management system. Most registers and functions are available for MODBUS access. Access is allowed using the RS485 MODBUS PORT connecter on the communication board. Version 2.x Control has these connections integrated on the main board.

An optional BACNet or LonWorks bridge module can be used to connect the MODBUS network to a BACnet or LonWorks network. See Method 5 control.

Failsafe Modes

FAILSAFE MODES have been added to help protect systems from loss of heat conditions. When using one of these modes **ensure that you connect any DAMPER control, or system pump control to safely allow operation** with the assumption that the MASTER boiler or BMS system is DOWN.

FAILSAFE REQUIREMENTS:

1. Since the Member boiler that will be assigned the Failsafe duty will always turn the system pump ON, this boiler should not be used for DHW heating. If the Master controls the system pump, then the Failsafe Member boiler would need to control the system pump in parallel with the Master boiler. Wire the System Pump contacts in parallel with the Master.

2. If the combustion air damper is used as a common system damper, the Failsafe boiler should be wired to control the damper in parallel with the Master boiler.

3. The Failsafe boiler must have the LOCAL SETPOINT set to the same setpoint temperature as the Master boiler's SYSTEM SETPOINT.

Be aware that the boiler may start without a call-for-heat in the FAILSAFE MODES. FAILSAFE MODES can be accessed through the:

`SETUP:AUX FUNCTIONS:FAILSAFE MODES`.

The following are types of Failsafe conditions.

1. Building Management System Failure

   If a BMS system is controlling the setpoint and enabling the boiler system, a timer is provided to allow operation of the system in the event that communications are lost with the BMS system. The HeatNet boiler system will run locally if communications is lost and this timer expires due to the lack of being updated.

   The system setpoint timer and system setpoint work in tandem to externally control (i.e. a BMS - building management system) the operating setpoint. The setpoint (countdown) timer should be loaded with a timeout value (in seconds) prior to writing the system setpoint. When the timer reaches zero, the control assumes that the BMS is no longer operating and the local setpoint (saved on the control) is reloaded. If the setpoint timer is not written, a default timeout value of 60 seconds is assumed. The timer is automatically reloaded with the default value when a setpoint is written.

   NOTICE The BMS mode is always on and no menu item is available.

2. HeatNet Communications Lost

   `SETUP:AUX FUNCTIONS:FAILSAFE MODES:H-NET COMM LOST`:

   This mode allows a member boiler to run in LOCAL if the communications link via the H-NET cable is lost. This includes the MASTER boiler losing its Control board, Communications board, or the power on the MASTER is switched OFF. When this MODE is set to ON, and if the member boiler loses it's link (heartbeat packet over the H-NET cable) to the MASTER Boiler, this MEMBER will fire to the LOCAL setpoint.

   NOTICE The heartbeat packet over the H-NET cable needs to be lost for 10 minutes.

   This MEMBER boiler will continue to run at the LOCAL setpoint until H-NET communications from the MASTER boiler is re-established.

Ensure that this Member boiler's Damper and System pump control are configured correctly with the assumption that the Master is not powered. Also ensure that any other System settings related to outside air temperature sensing and system interlocks are set to provide safe operation.

3. Low Temperature Protection

LOW TEMP: OFF, SUPPLY, HEADER, DHW, or RETURN

This mode may be used by the MASTER or MEMBER boiler and can be used as a type of freeze protection. In this mode you may select which Sensor you wish to monitor, or you may opt to turn this mode OFF. If you select a sensor, you may then associate it with a temperature at which the boiler will turn ON. Once the temperature at this sensor falls below the LOW TEMP temperature the boiler will start and fire to its LOCAL setpoint. Once the Boiler reaches it's setpoint it will turn OFF.

4. Using the Base Load Relay (Version 2.x)

If there are no boilers available to fire (offline or faulted) and there are no boilers in local override, and there is a call for heat, The J4 Base Load relay will close. If a boiler becomes available and needs to fire, the Base Load boiler will remain firing until the temperature exceeds the band. This is provided to keep the system from entering a no heat situation.

Version 2.x Control

The second generation HeatNet control incorporates some new and additional features. The firmware automatically detects the presence of the version 2.x control. These features include:

1. Support for Domestic Hot Water using a temperature sensor or a dry contact from a tank thermostat. Also, a separate relay contact for a DHW pump or Valve is provided.

2. On-Board HeatNet and Modbus connections. Also, added a second terminal connector for daisy chaining the H-Net connections when using shielded wire.

3. Added a low fire hold switch for ease in calibrating.

4. Added a 'U' shaped socket system for mounting the Protocessor module. No other wiring connectors are required when connecting BACnet & LonWorks, other than the BACnet or LonWorks network cable.

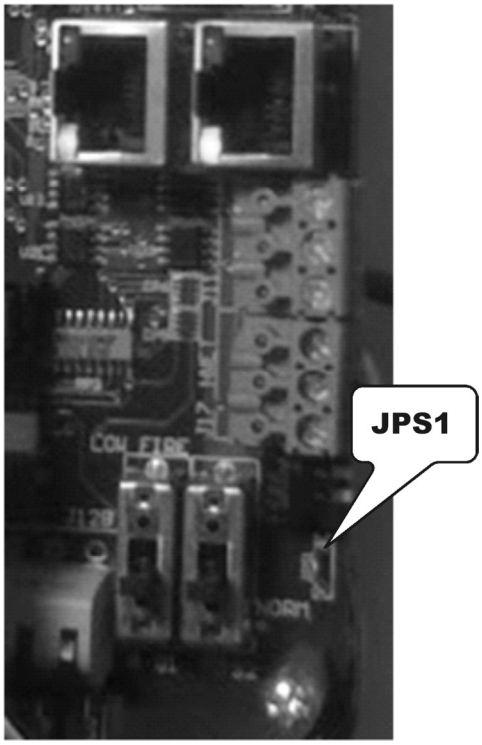
5. Support for the KN XLF with 12 VDC, 1 amp power control for the Pilot assembly.

6. Interlock string is now fused with a resettable fuse onboard (F4).

Domestic Hot Water Methods

The Version 2.x control supports Domestic Hot Water control using (4) methods. When using the Domestic Hot Water methods, the wire jumper, JPS1 on each control board providing Domestic Hot Water, must be cut to limit the boiler's maximum output temperature of 200F. Refer to Figure 42 for control input and output locations.

Figure 28 Jumper JPS1



The following Domestic Hot Water setup information will include a walkthrough using the menus.

DHW METHOD 1: DHW Tank Sensor Input

Available on V2.X Controls ONLY

DHW METHOD 1a: DHW Heating ONLY using a Single Boiler or a DHW MASTER and Member boiler(s) employing H-Net

This method utilizes a 10k thermistor connected to the DHW Sensor input of a DHW MASTER, or a stand alone boiler, and a DHW tank WITHOUT a HEADER sensor. It requires a DHW setpoint and other parameters to be set. This method is used when the water temperature in the tank needs to be no greater than the setpoint, with little overshoot of temperature. One of its limitations is that it may short cycle. It functions much in the same way a tank thermostat works.

This method works with (2) settings. A target tank water setpoint (DHW SETPOINT) and a start/add boiler temperature setting (DHW DIFF). Boilers are started as long as the tank's water temperature is below the (DHW SETPOINT – DHW DIFF). The first boiler is started immediately. The next boiler(s) is started after the ADD BOILER DELAY time expires. Boilers are not added when the temperature is above the (DHW SETPOINT – DHW DIFF) and below the DHW SETPOINT. Once the DHW SETPOINT is reached all boilers shut off. This limits the tank temperature to the setpoint + post purge time of the DHW pump.

Setting up this method is done via the menus in: **SETUP:DOMESTIC HOT WATER.**

1. Connect a 10k thermistor from the DHW tank's sensor well to J10B terminals 1 & 2 on the DHW MASTER, or stand alone boiler. Wire any pump or valve from the DHW Pump relay (normally open) contact to control flow of the heating water into the tank's coil.
2. Next, enter the **DOMESTIC HOT WATER** menu. When prompted for **DHW BOILER?**, enter **NO**. We will enter **YES** when we are finished entering all parameters
3. Change the **DHW SETPOINT** to the desired target temperature of the water in the tank. Once the control determines there is a call for DHW, the DHW SETPOINT is loaded and the Master boiler will target this new setpoint.
4. Now, change the **DHW DIFF** to the desired differential. This setting corresponds to the minimum water temperature required in the tank. DHW heating will be initiated when the DHW tank's water temperature is below the **DHW SETPOINT – DHW DIFF**.
5. How long the temperature of the tank stays below the (DHW SETPOINT – DHW DIFF) is used to determine when boilers are started along with the **ADD BOILER DELAY**.
6. Scroll down to **USE SENSOR?** Press the **SELECT** key and select **YES,** then press the **SELECT** key again**.** This will allow the boiler to control the tank temperature using its sensor.
7. Press the DOWN arrow key again to position the cursor beside the menu item **DHW PRIORITY?**. Setting this value to YES will turn OFF the system pump when the DHW mode is active. Setting this value to NO leaves the system pump on.
8. Press the DOWN arrow again and the menu item **POST PURGE** should appear. This is the time that the DHW pump relay remains energized after the DHW SETPOINT has been satisfied. Once

the tank has reached setpoint all boilers will shut off. Using the POST PURGE time to dump the boiler's heat into the tank may heat the tank above the setpoint temperature. Care should be taken here.

9. Press the DOWN arrow again and the menu item: **DHW MASTER?,** will be displayed. If this item is set to **YES,** once the DHW MASTER receives a HEAT DEMAND signal, it will call other boilers it has available using H-Net. Setting to **NO**, requires no Heat Demand signal, and will only enable the single boiler when the DHW Tank Temperature drops below (DHW SETPOINT – DHW DIFF).

   NOTE: DHW MASTER? YES is to be only be used WITHOUT a Header Sensor.

10. Finally, go to **DHW BOILER?**. Select **YES**. If JPS1 has not been cut, a message will appear instructing to do so. Once this is done, the stand alone boiler will control the temperature in the tank, or the DHW Master will control the temperature in the tank using as many boilers as it has available on H-Net.

    NOTE: DHW BOILER? Does not need to be set to **YES** on MEMBER boilers, only the DHW MASTER or on a stand alone boiler providing DHW.

    NOTE: JPS1 MUST be cut on all boilers providing DHW.

DHW METHOD 1b: Combo DHW and Space Heating using a MASTER Boiler and Member boiler(s) employing H-Net

This method utilizes a 10k thermistor connected to the DHW Sensor input of a MASTER boiler, a DHW tank AND a HEADER sensor. This Method works the same as DHW METHOD 1a, but also has the ability to provide space heating.

Setting up the DHW portion of this method is done via the menus in: **SETUP:DOMESTIC HOT WATER.** For information on setting up the space heating portion of the method Refer to **Heat Demand Control Method 1** located in the CONTROL METHODS section on page 22.

1. Connect a 10k thermistor from the DHW tank's sensor well to J10B terminals 1 & 2 on the MASTER, and connect a Header Sensor to the SYSTEM HEADER input. Wire any pump or valve from the DHW Pump relay (normally open) contact to control flow of the heating water into the tank's coil.

2. Next, enter the **DOMESTIC HOT WATER** menu. When prompted for **DHW BOILER?**, enter **NO**. We will enter **YES** when we are finished entering all parameters

3. Change the **DHW SETPOINT** to the desired target temperature of the water in the tank. Once the control determines there is a call for DHW, the DHW SETPOINT is loaded and the Master boiler will target this new setpoint.

4. Now, change the **DHW DIFF** to the desired differential. This setting corresponds to the minimum water temperature required in the tank. DHW heating will be initiated when the DHW tank's water temperature is below the **DHW SETPOINT – DHW DIFF**.

5. Since the same the **ADD BOILER DELAY** time is used for space heating and DHW, how long the temperature of the tank stays below the (DHW SETPOINT – DHW DIFF) has to be considered when setting the **ADD BOILER DELAY**.

6. Scroll down to **USE SENSOR?** Press the **SELECT** key and select **YES,** then press the **SELECT** key again**.** This will allow the boiler to control the tank temperature using its sensor.

7. Press the DOWN arrow key again to position the cursor beside the menu item **DHW PRIORITY?**. Setting this value to YES will turn OFF the system pump when the DHW mode is active. Setting this value to NO leaves the system pump on.

8. Press the DOWN arrow again and the menu item **POST PURGE** should appear. This is the time that the DHW pump relay remains energized after the DHW SETPOINT has been satisfied. If there is no HEAT DEMAND signal, once the tank has reached setpoint all boilers will shut off, and the post purge time will begin. If there is a HEAT DEMAND Signal when the tank has reached setpoint, the boilers will continue running to provide space heating, and the DHW pump relay will be de-energized immediately. Using the POST PURGE time to dump the boiler's heat into the tank may heat the tank above the setpoint temperature. Care should be taken here.

9. Press the DOWN arrow again and the menu item: **DHW MASTER?,** will be displayed. Set it to NO for this DHW Method.

   NOTE: This DHW Method requires no Heat Demand signal to control the temperature in the tank. As soon as the DHW Tank Temperature drops below (DHW SETPOINT – DHW DIFF) a boiler will be enabled.

NOTE: DHW MASTER? YES is only to be used WITHOUT a Header Sensor. When both a Header Sensor and a DHW Tank Sensor are installed, because it has a HEADER Sensor, the Boiler will recognize itself as a MASTER. When DHW BOILER? is also set to YES, the MASTER will automatically call on other boilers when the DHW Tank Temperature drops below (DHW SETPOINT – DHW DIFF) even when no Heat Demand signal is present. However, the MASTER will only enable boilers for space heating in response to a Heat Demand signal.

10. Finally, go to **DHW BOILER?**. Select **YES**. If JPS1 has not been cut, a message will appear instructing to do so. Once this is done, the MASTER boiler will control the temperature in the tank using as many boilers as it has available on H-Net.

    NOTE: DHW BOILER? Does not need to be set to **YES** on MEMBER boilers, only the MASTER boiler.

    NOTE: JPS1 MUST be cut on all boilers providing DHW.

DHW METHOD 2: DHW Header Sensor Input

Available on both V1.X and V2.X Controls

1. This method will control a tank temperature when the tank temperature setpoint needs to be maintained for extended periods with minimal cycling. Multiple boilers can be used via the H-Net, as this method employs the same PID algorithm as for space heating. For this method, a tank temperature band needs to be tolerated. JPS1 MUST be cut on all boilers providing DHW to ensure the maximum output temperature of all boiler is limited for DHW operation.
2. Use the **Heat Demand Control Method 1** located in the CONTROL METHODS section on page 22. Instead of placing the Header sensor in the Header pipe, place it in a well in the tank.

   The temperature at which boilers are staged **ON,** and then **OFF** is controlled by the **SETUP:BOILERS:HEAT BAND** differential. This can be understood by referring to the INTRODUCTION section on the MASTER in the beginning of this manual.

   This differential has the added effect of heating the tank above the tank's setpoint temperature. If the tank setpoint is set to 140F and the heat band is set to 10F, then the tank temperature will rise to 145F before the first boiler turns off (setpoint =140F +/-heat band/2). With (2) boilers running, the **SHED BOILER DELAY** time could add to the tank temperature. So, to ensure that all boilers are shut off at the upper point of the heat band, set the **SHED BOILER DELAY time to 0**. This will effectively turn off all boilers at the upper heat band point of: (example) 145F.

   Now, there is one more thing to consider, the pump's post purge time. Dumping the heat from all boilers (that were running) using a pump post purge cycle will have an effect on the tank's water temperature. Consider this when establishing the local pump's **POST PURGE TIME**.

3. Connect the Local Pump relay contact on J13 to enable the DHW pump. Set its post purge time to dump the boiler's heat into the tank when the boiler shuts off. **Be aware that this may heat the tank above the setpoint's upper heat band temperature.**
4. Enable the system by placing the LOCAL/REMOTE switch on the Master to the LOCAL position.

DHW METHOD 3: Space Heating with DHW Override

Available on both V1.X and V2.X Controls

This method is for controlling DHW utilizing a tank thermostat connected to a Master or Member boiler. This method can be used instead of the 10k thermistor sensor. When the thermostat contact closes across the input **OA OVR (J12A .7 & .8),** the control will sense this closure and enter the DHW heating mode.

In this mode, the boiler will fire to **100%** and be regulated by the **OPERATE LIM** setting located in **SETUP:SETPOINTS.** The **OP LIM BAND** can be used to keep the boiler from short cycling too much by limiting the firing rate as it approaches the **OPERATE LIM**.

1. Wire the dry contact from the thermostat on the tank to the input on J12A terminal 7 & 8. Also, at this time wire any pump or valve from the DHW Pump relay (normally open) contact (J13

terminals 9, 10) to control flow of the heating water into the tank's coil.

2. Enter the **DOMESTIC HOT WATER MENU**. When prompted for **DHW BOILER?**, enter **NO**. We will enter **YES** when we are finished entering all parameters

   Follow the same steps as used to program the 10k thermistor sensor method, but when asked to **USE SENSOR?,** select **NO**.

   Set the **DHW MASTER** to **NO.** A thermostat can only control (1) boiler. H-Net is not available with a thermostat on the tank.

   Go to the **DHW BOILER?**, enter and select **YES**. The Master or Member will now control the temperature in the tank.

DHW METHOD 4: DHW using Direct Control

Available on both V1.X and V2.X Controls

Firmware Version 3.0 adds the ability to set the 4-20 mA input to HIGH PRIORITY. This can be set in menu: **ADVANCED SETUP:4-20mA INPUT**. This allows a member boiler to be taken offline and directly modulated by an external control.

If the Master is using it for heating and the 4-20mA is set to HIGH PRIORITY, an external control can now output a 4-20mA signal which will take over the boiler's fire rate and override all other heating demand inputs. This is typically used for DHW control.

Wiring Connections

Figure 29 Power connections — **Version 1.X control factory wiring (blue pc board)**

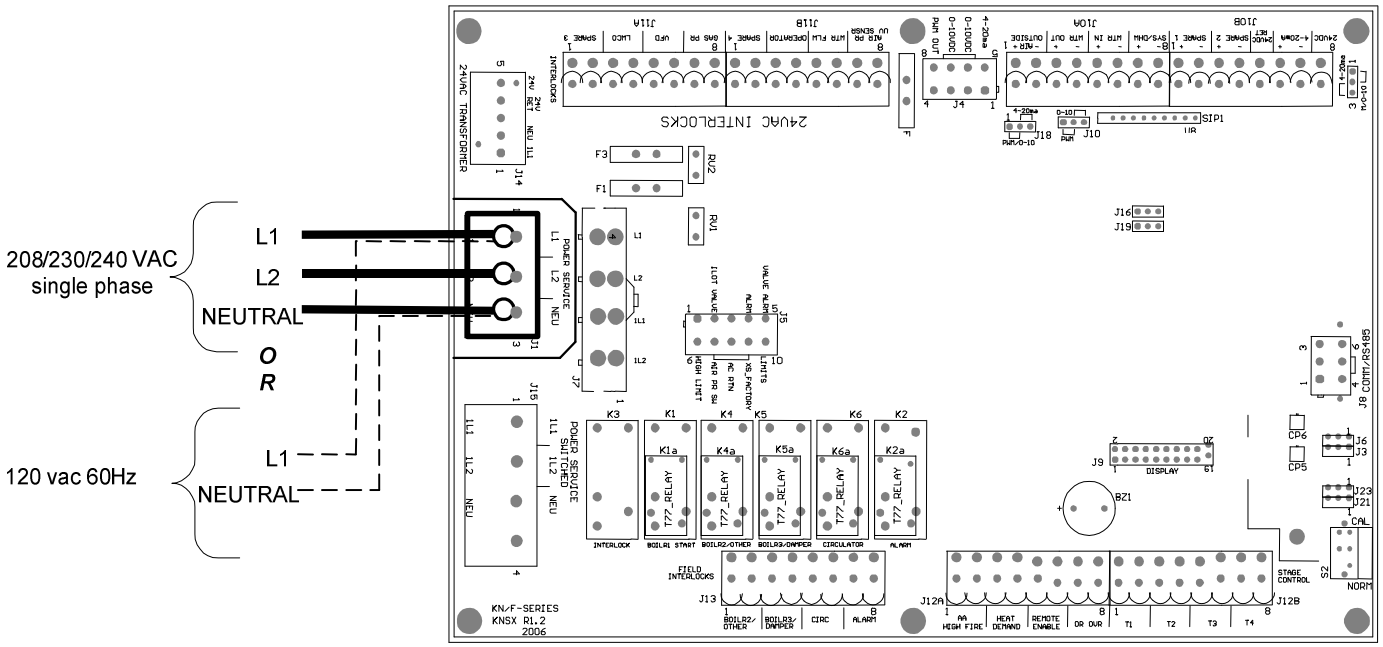


Figure 30 Power connections — **Version 2.X control factory wiring (green pc board)**

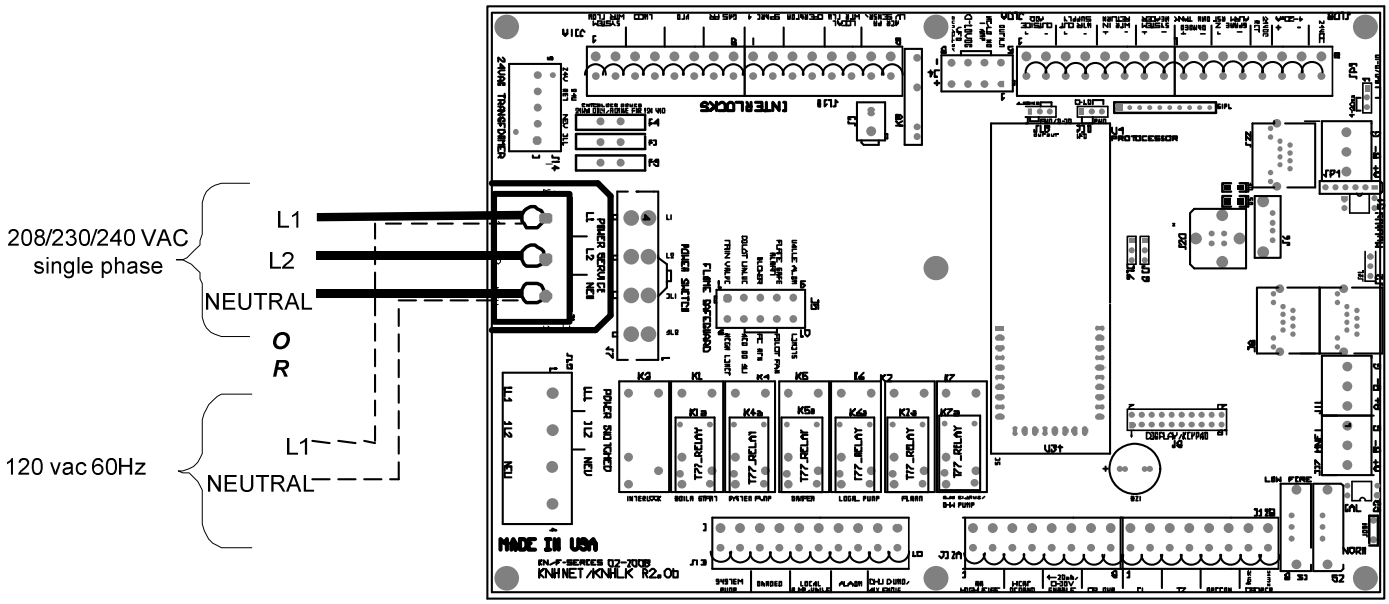


Figure 31 Heating Method 1 H-Net, Master/member — **Version 1.x control (blue pc board)**

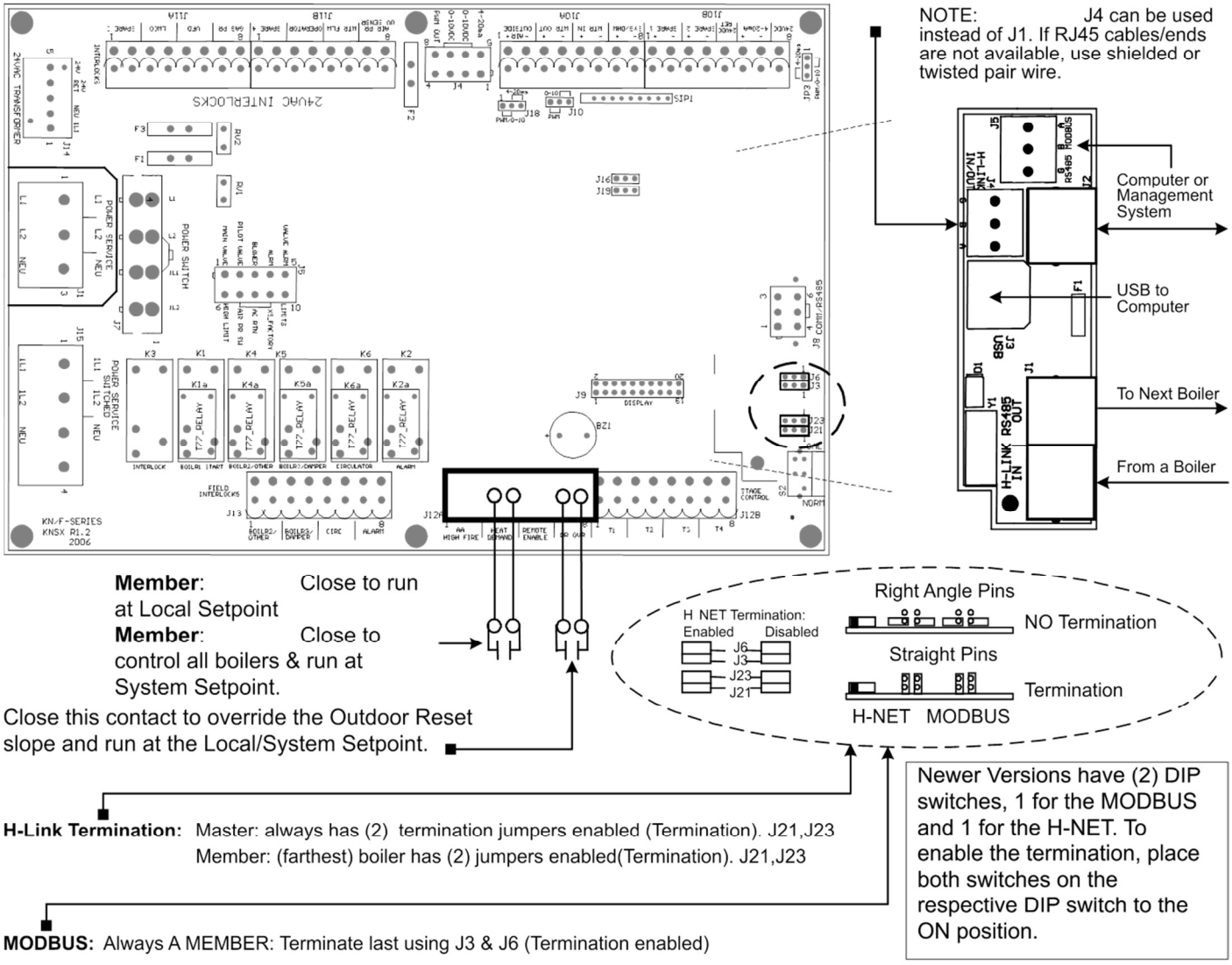

NOTE: J4 can be used instead of J1. If RJ45 cables/ends are not available, use shielded or twisted pair wire.
Computer or Management System
USB to Computer
To Next Boiler
From a Boiler
H-LINK IN
H-LINK OUT
RS485 MODBUS
USB
24VAC INTERLOCKS
24VAC TRANSFORMER
POWER SERVICE
POWER SWITCH
POWER SERVICE SWITCHED
FIELD INTERLOCKS
DISPLAY
KN/F-SERIES KNSX R1.2 2006
Member: Close to run at Local Setpoint
Member: Close to control all boilers & run at System Setpoint.
Close this contact to override the Outdoor Reset slope and run at the Local/System Setpoint.
H NET Termination:
Enabled Disabled
J6
J3
J23
J21
Right Angle Pins
NO Termination
Straight Pins
Termination
H-NET MODBUS
H-Link Termination: Master: always has (2) termination jumpers enabled (Termination). J21,J23
Member: (farthest) boiler has (2) jumpers enabled(Termination). J21,J23
MODBUS: Always A MEMBER: Terminate last using J3 & J6 (Termination enabled)
Newer Versions have (2) DIP switches, 1 for the MODBUS and 1 for the H-NET. To enable the termination, place both switches on the respective DIP switch to the ON position.

Figure 32 Heating Method 1 H-Net, Master/member — **Version 2.x control (green pc board)**

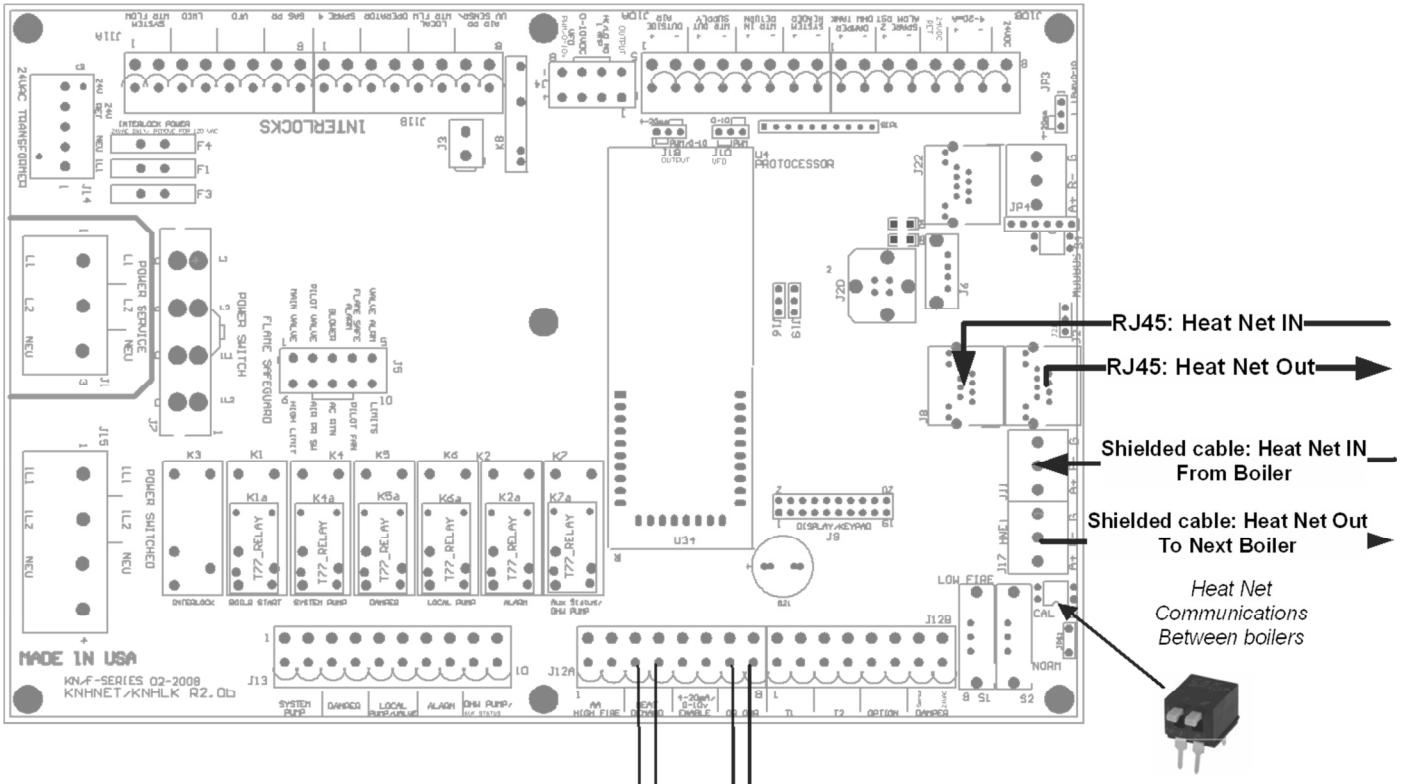
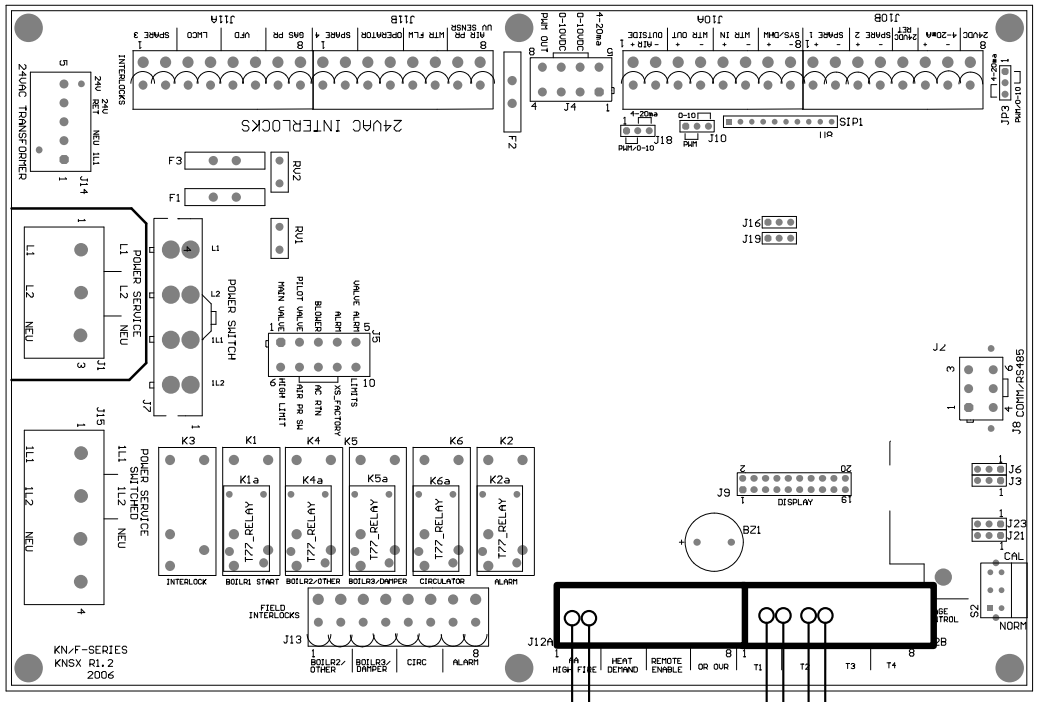

RJ45: Heat Net IN
RJ45: Heat Net Out
Shielded cable: Heat Net IN From Boiler
Shielded cable: Heat Net Out To Next Boiler
Heat Net Communications Between boilers
Member: Close to run at Local Setpoint
Member: Close to control all boilers & run at System Setpoint.
Close this contact to override the Outdoor Reset slope and run at the Local/System Setpoint.
DIP Switch shown: NOT Terminated
Push both white switches down to enable H-Net or Modbus termination. Termination is required on MASTER and last Member boiler.

Figure 33 Heating Methods 2 and 4: AA-High Fire and High/Low, master or member boiler
(Version 1 board = blue; version 2 board = green)



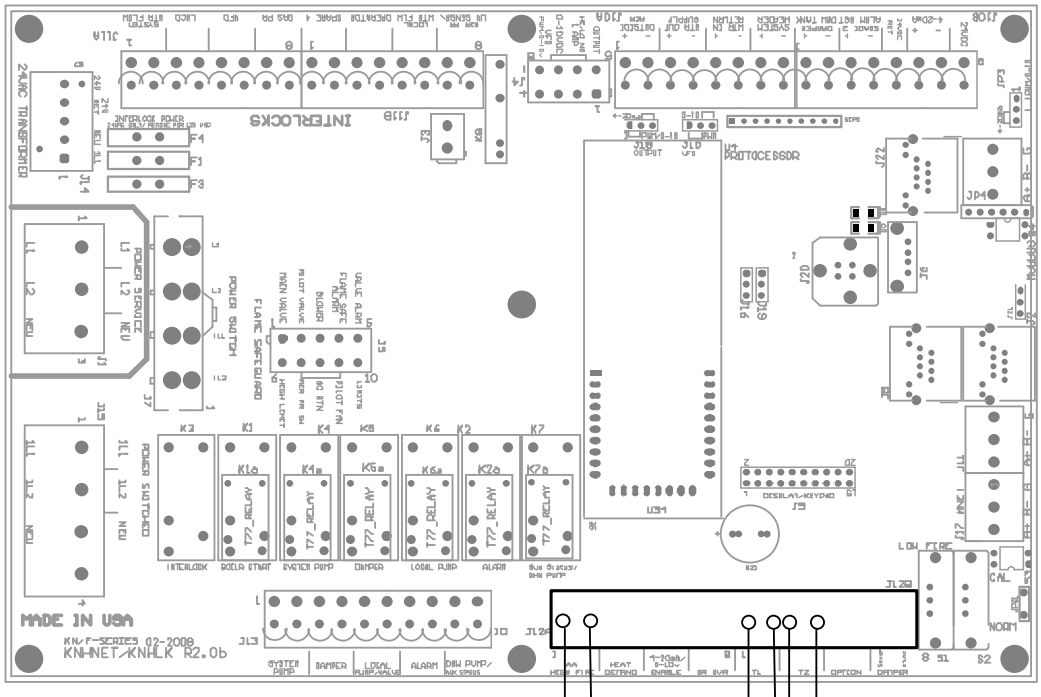
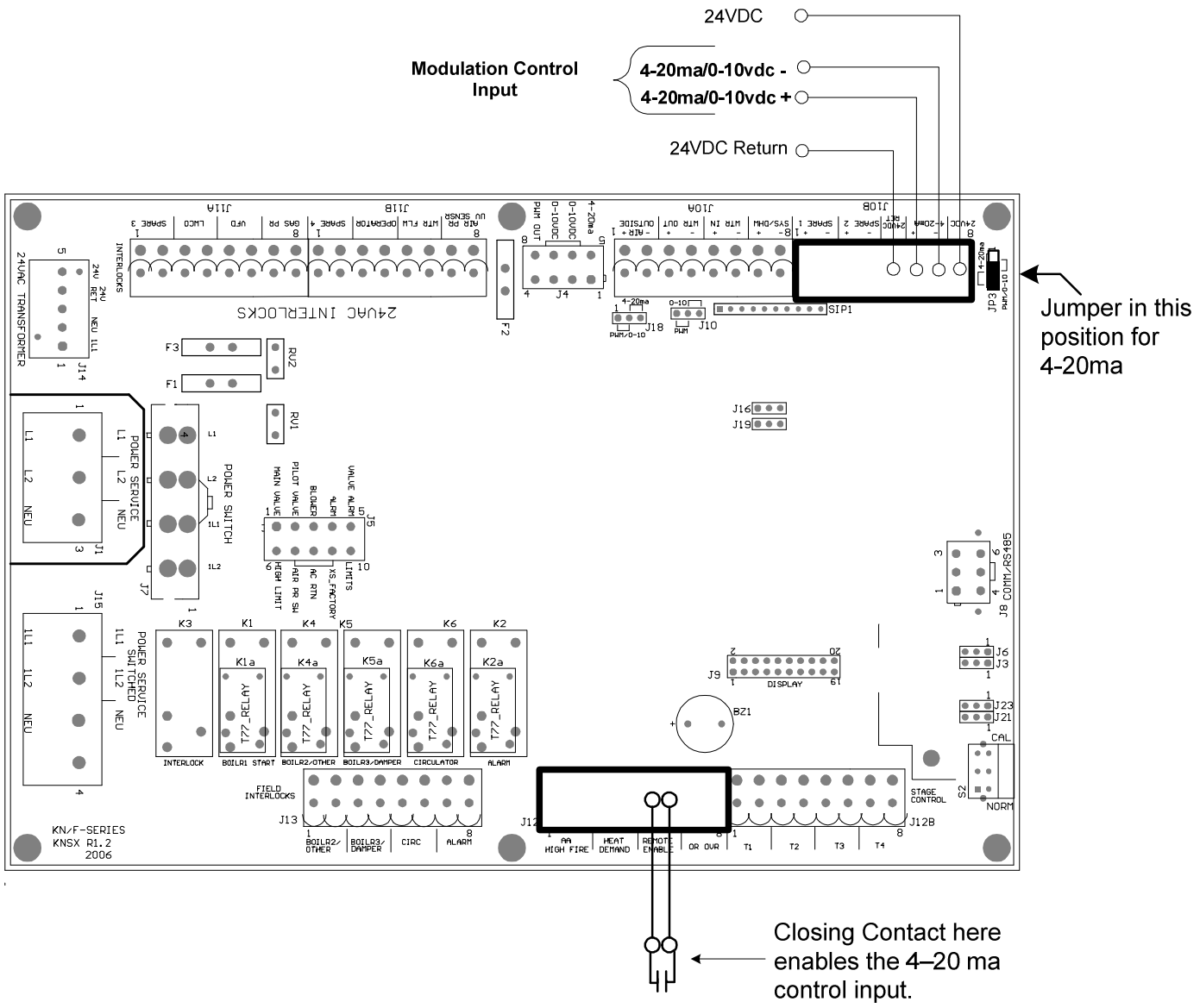


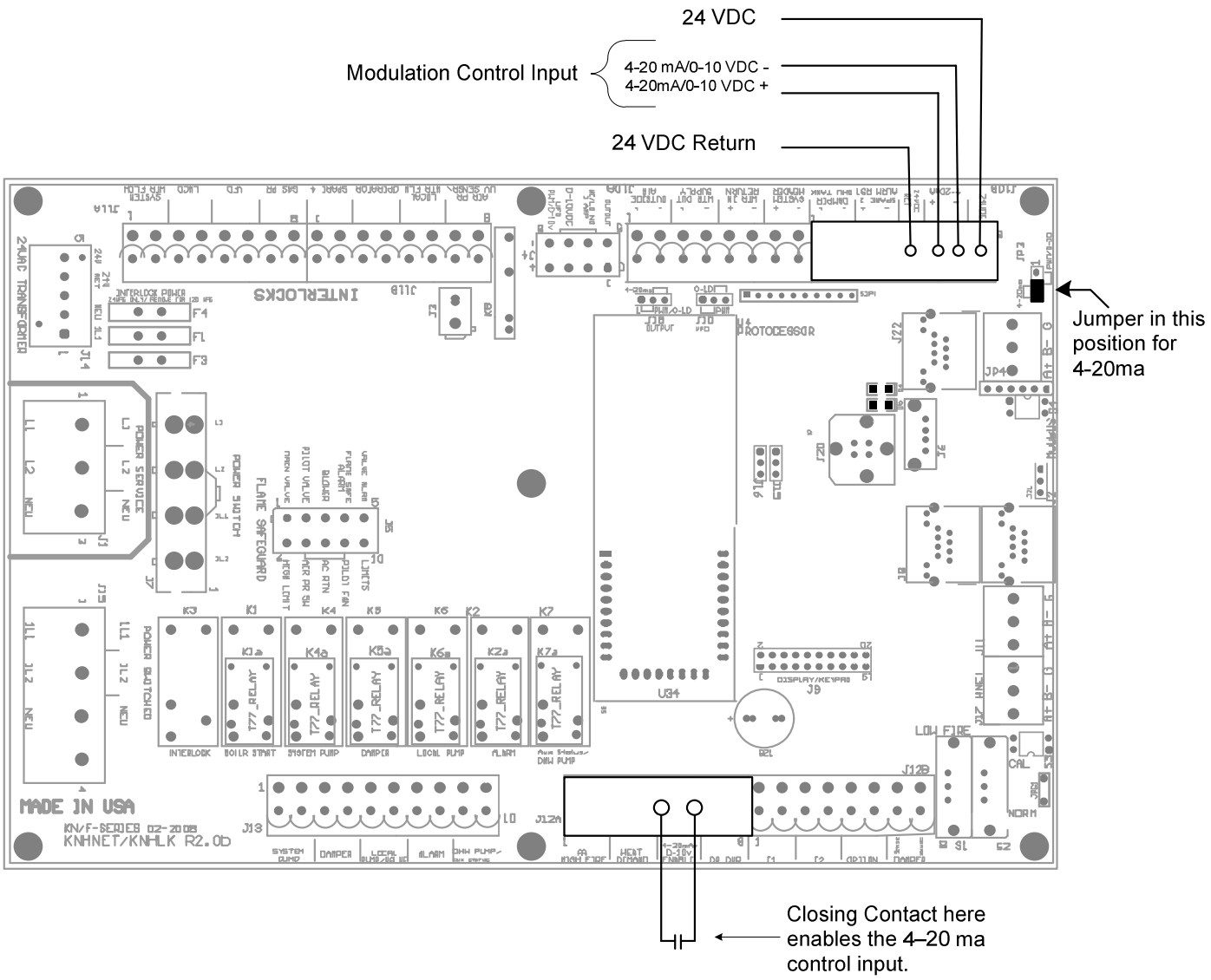
Figure 34 Heating Method 3 4–20 ma — **Version 1.x control (blue pc board)**



This Method allows direct modulation of the boiler based on a 4-20 mA control signal. A control capable of transmitting a 4-20mA/0-10 VDC control signal for the purpose of modulating a boiler and to control a common system temperature must be used with this method.

NOTE: If using a 0-10 VDC signal multiply any references to current in the manual by .5. Example: 5ma * .5 = 2.5 VDC

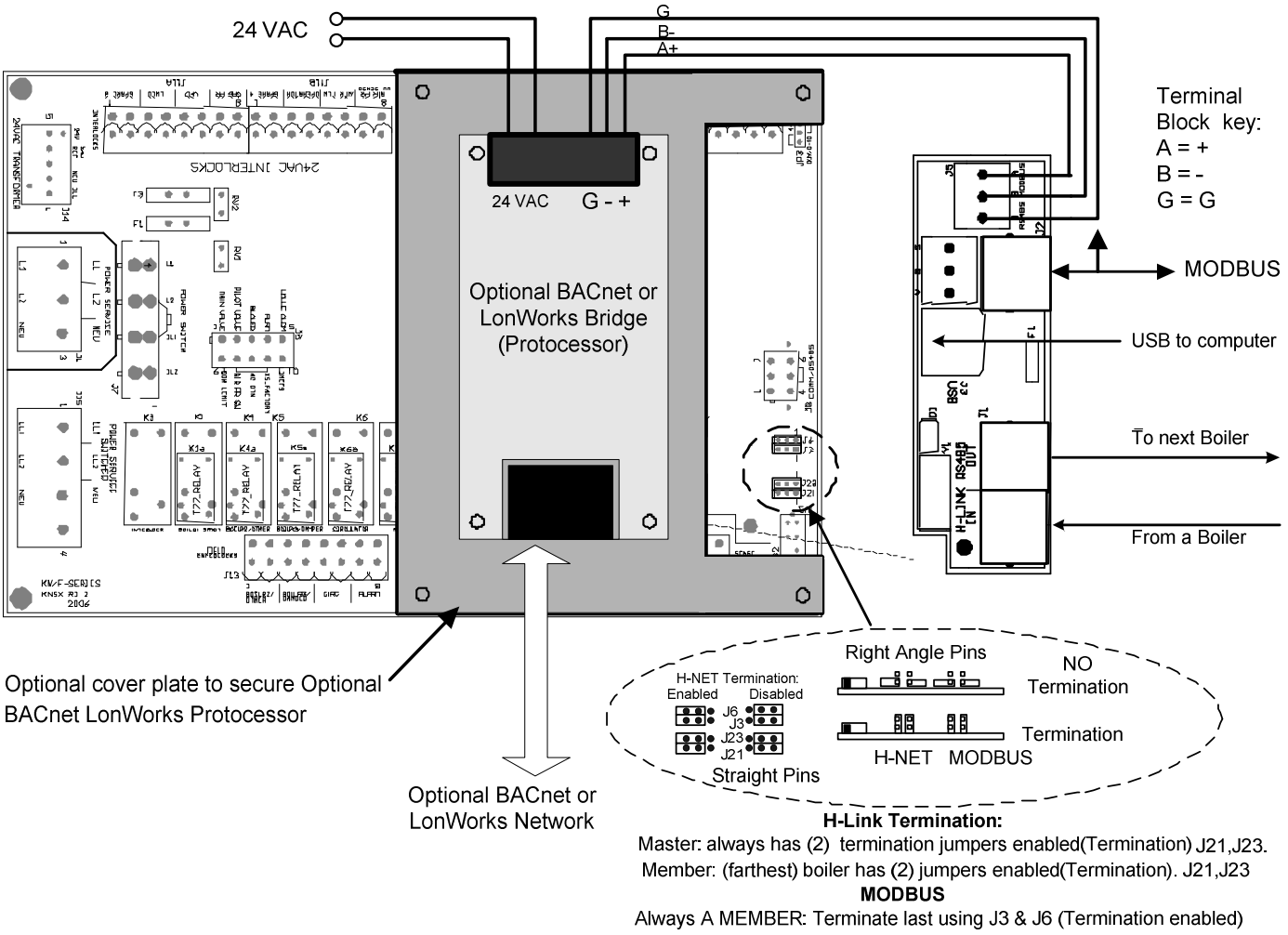
Figure 35 Heating Method 3 4–20 ma — **Version 2.x control (green pc board)**


24 VDC
Modulation Control Input
4-20 mA/0-10 VDC -
4-20mA/0-10 VDC +
24 VDC Return
Jumper in this position for 4-20ma
Closing Contact here enables the 4–20 ma control input.

This Method allows direct modulation of the boiler based on a 4-20 mA control signal. A control capable of transmitting a 4-20mA/0-10 VDC control signal for the purpose of modulating a boiler and to control a common system temperature must be used with this method.

NOTE: If using a 0-10 VDC signal multiply any references to current in the manual by .5. Example: 5ma * .5 = 2.5 VDC

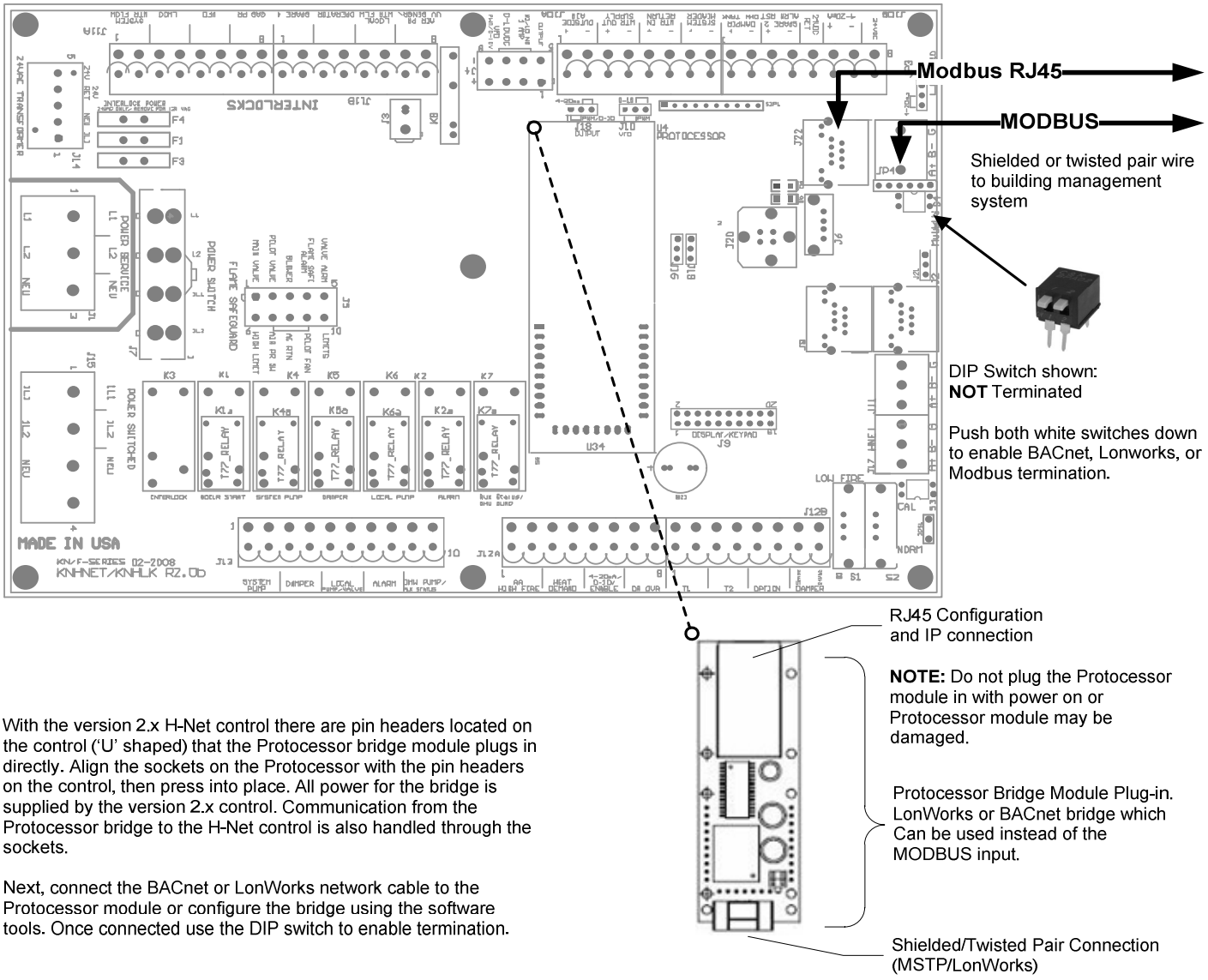
Figure 36 Heating Method 5: MODBUS (Optional BACnet or LonWorks bridge — Protocessor) — **Version 1.x control (flue pc board)**



H-Link Termination:
Master: always has (2) termination jumpers enabled(Termination) J21,J23.
Member: (farthest) boiler has (2) jumpers enabled(Termination). J21,J23
MODBUS
Always A MEMBER: Terminate last using J3 & J6 (Termination enabled)

Additional Bulletins and Instructions for Configuring BACnet or LonWorks are available on the website at http://www.RBIWATERHEATERS.com

Figure 37 Heating Method 5: MODBUS (Optional BACnet or LonWorks bridge — Protocessor) — **Version 2.x control (green pc board)**


Modbus RJ45
MODBUS
Shielded or twisted pair wire to building management system
DIP Switch shown: **NOT** Terminated
Push both white switches down to enable BACnet, Lonworks, or Modbus termination.
RJ45 Configuration and IP connection
NOTE: Do not plug the Protocessor module in with power on or Protocessor module may be damaged.
Protocessor Bridge Module Plug-in. LonWorks or BACnet bridge which Can be used instead of the MODBUS input.
Shielded/Twisted Pair Connection (MSTP/LonWorks)

With the version 2.x H-Net control there are pin headers located on the control ('U' shaped) that the Protocessor bridge module plugs in directly. Align the sockets on the Protocessor with the pin headers on the control, then press into place. All power for the bridge is supplied by the version 2.x control. Communication from the Protocessor bridge to the H-Net control is also handled through the sockets.

Next, connect the BACnet or LonWorks network cable to the Protocessor module or configure the bridge using the software tools. Once connected use the DIP switch to enable termination.

Additional Bulletins and Instructions for Configuring BACnet or LonWorks are available on the website at http://www.RBIWATERHEATERS.com

Figure 38 Relays, Interlocks and Boiler Status — **Version 1.x control (blue pc board)**

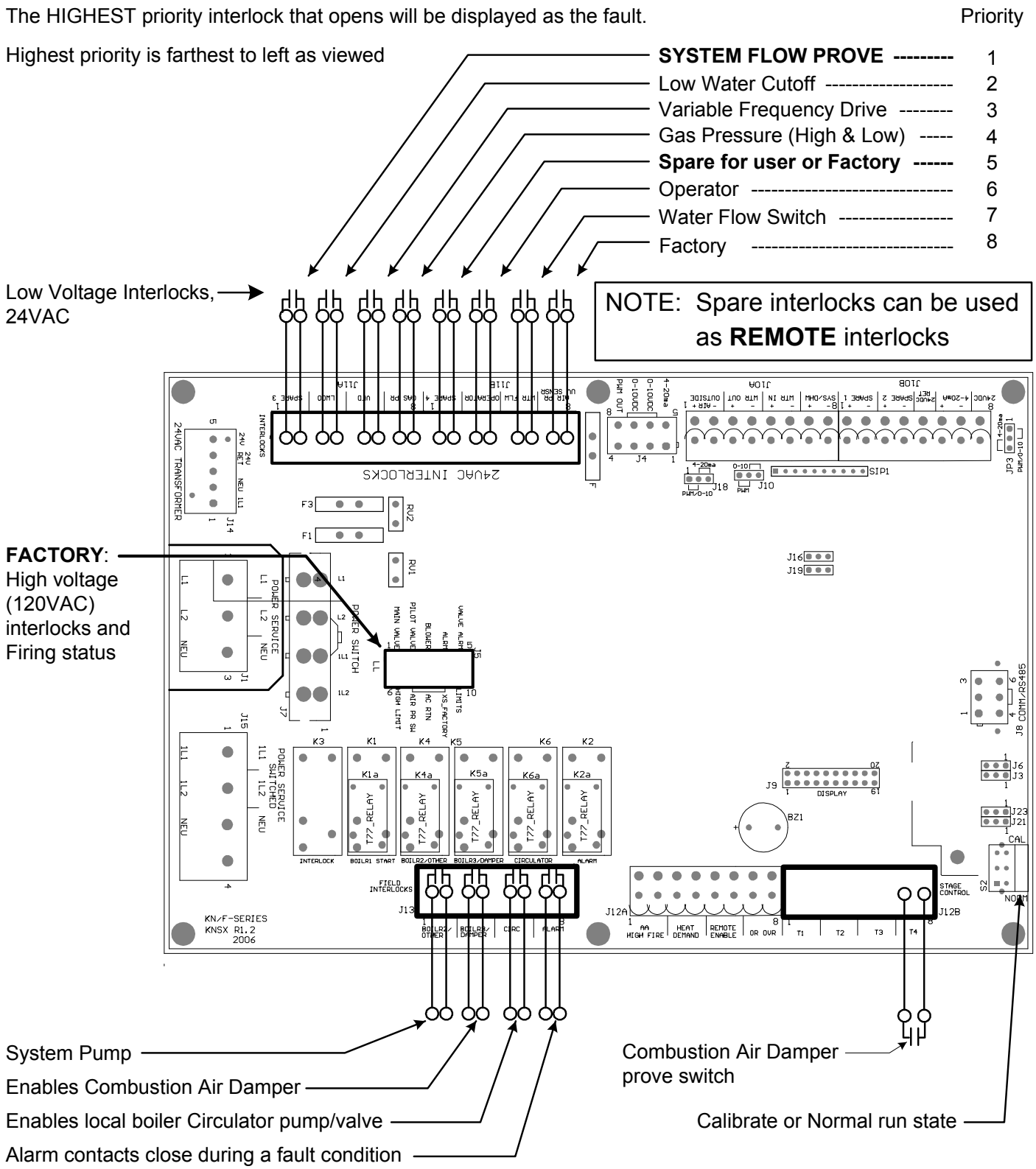


Figure 39 Relays, Interlocks and Boiler Status — **Version 2.x control (green pc board)**

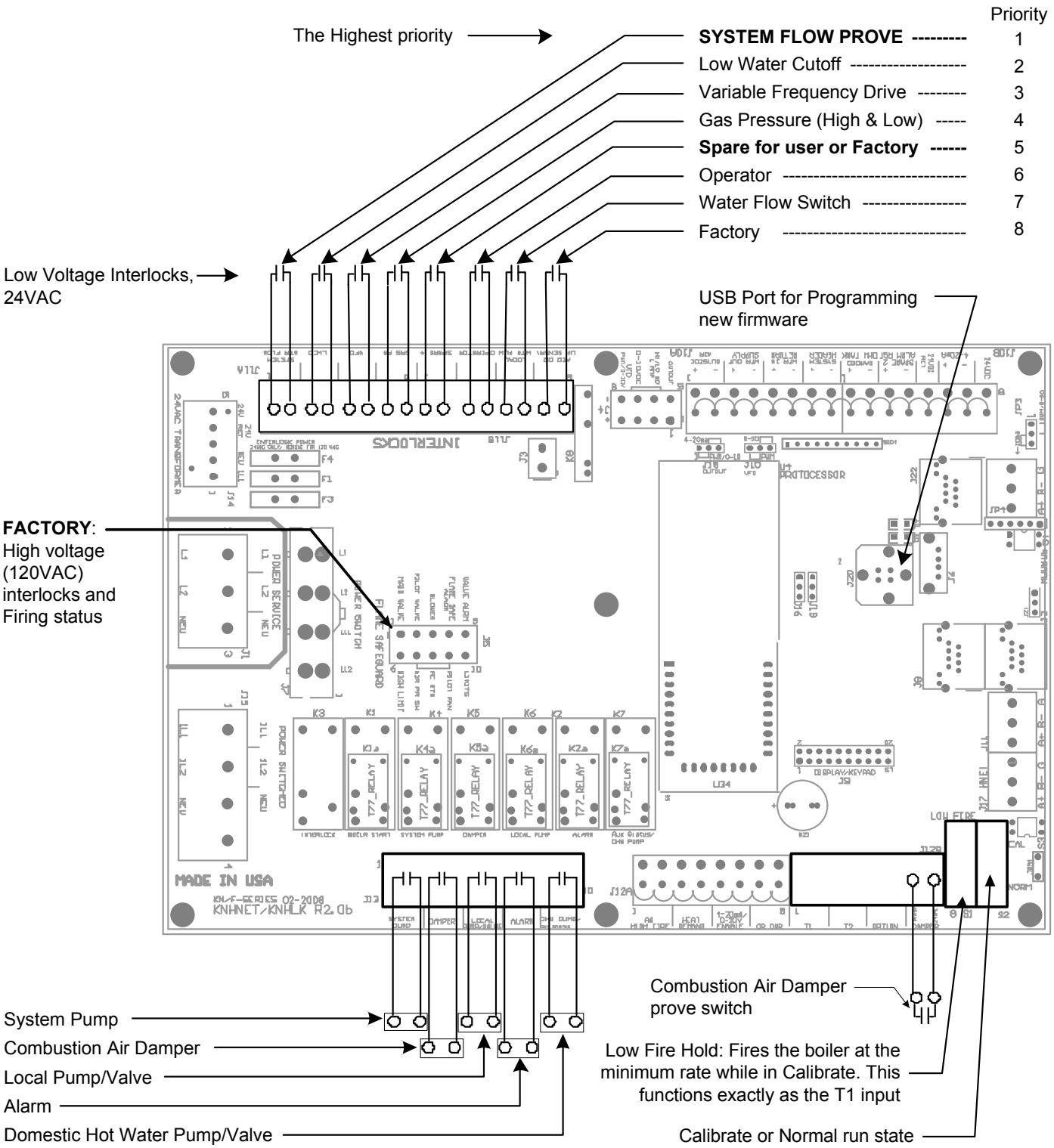
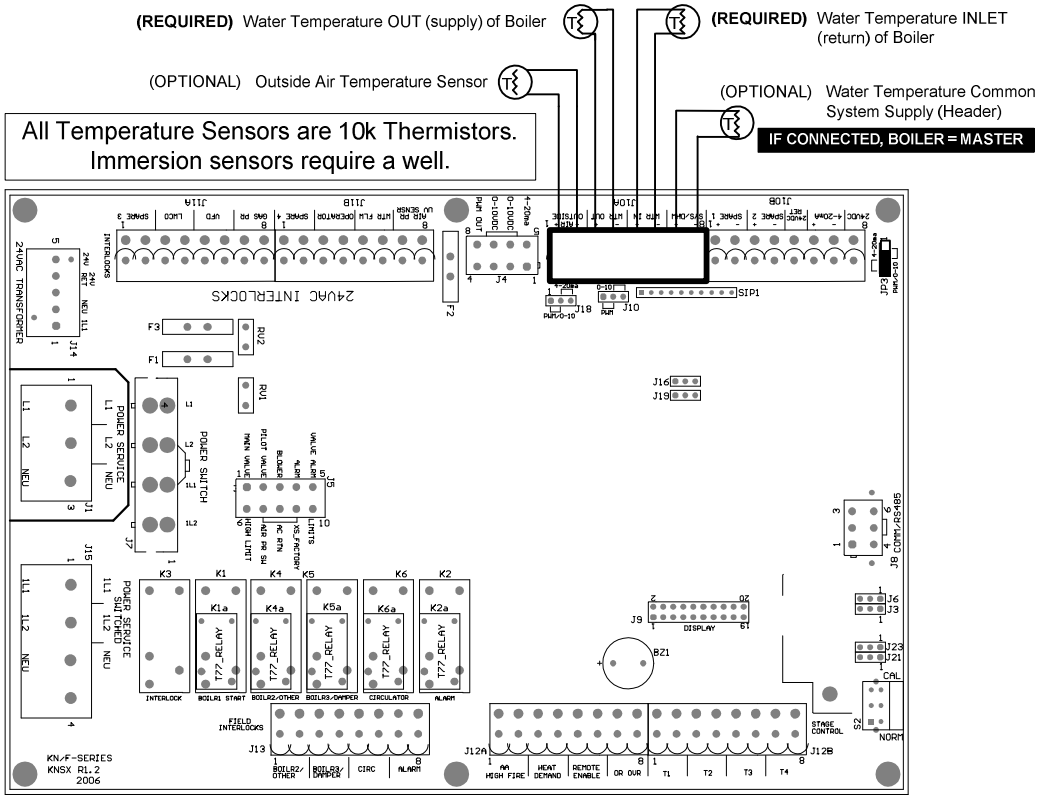

Priority
The Highest priority
SYSTEM FLOW PROVE --------- 1
Low Water Cutoff ---------- 2
Variable Frequency Drive -------- 3
Gas Pressure (High & Low) ----- 4
Spare for user or Factory ------ 5
Operator ---------- 6
Water Flow Switch ---------- 7
Factory ---------- 8
Low Voltage Interlocks, 24VAC
USB Port for Programming new firmware
FACTORY: High voltage (120VAC) interlocks and Firing status
System Pump
Combustion Air Damper
Local Pump/Valve
Alarm
Domestic Hot Water Pump/Valve
Combustion Air Damper prove switch
Low Fire Hold: Fires the boiler at the minimum rate while in Calibrate. This functions exactly as the T1 input
Calibrate or Normal run state

Figure 40 Temperature sensors (Top board, version 1 = blue / Bottom board, version 2 = green)



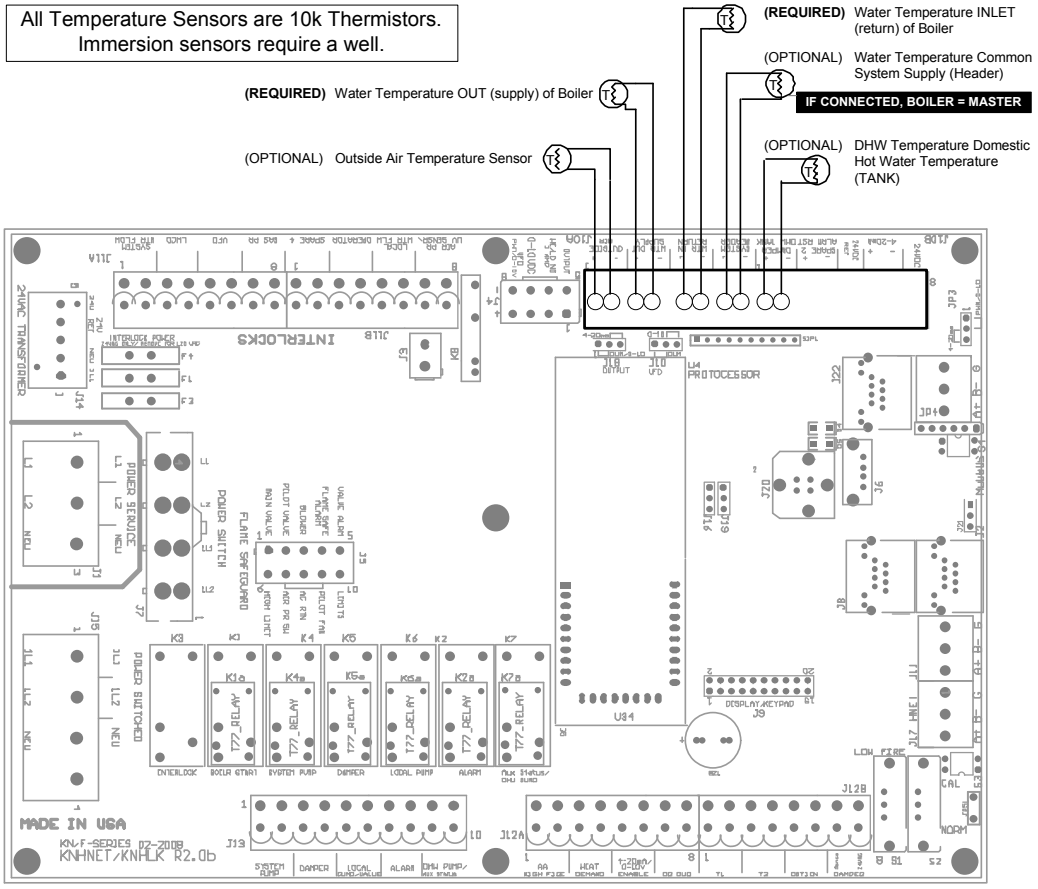
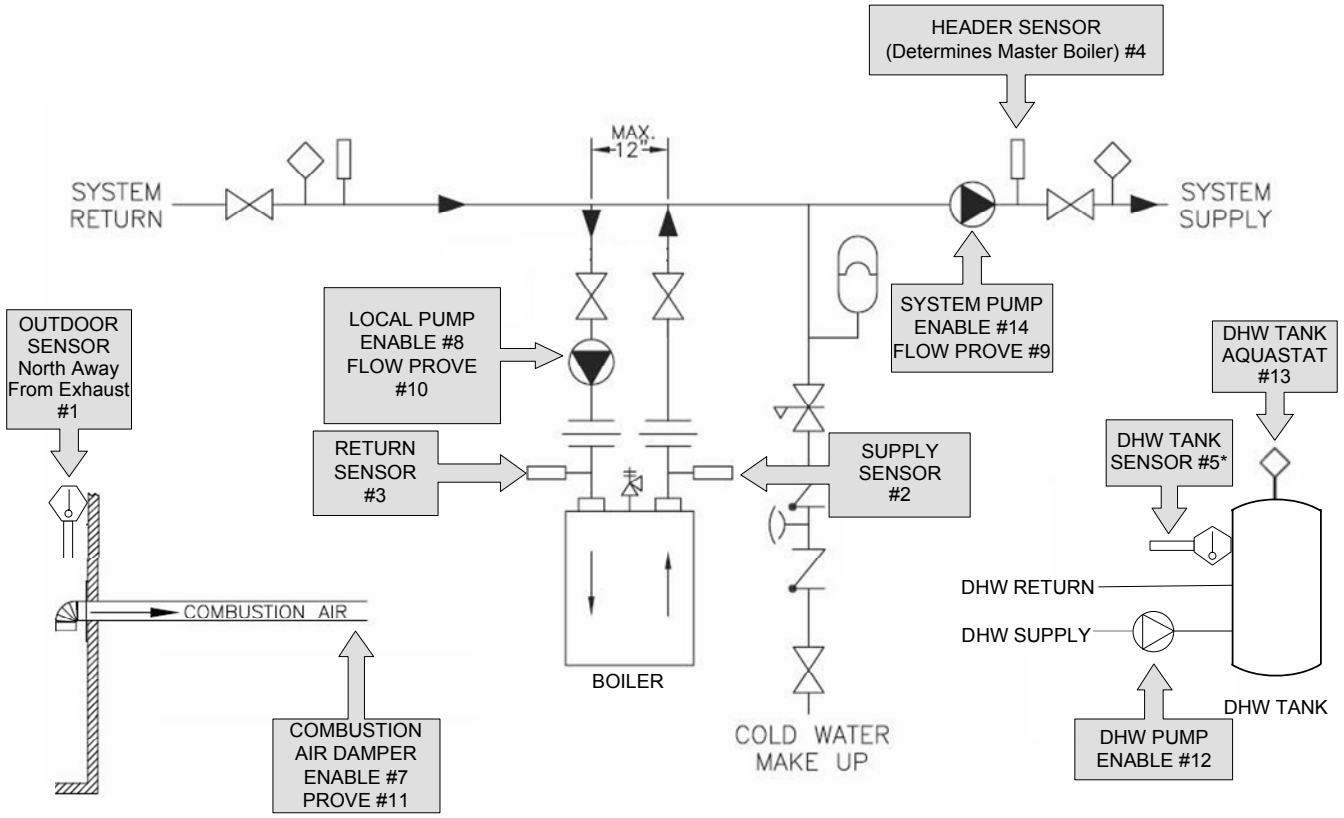
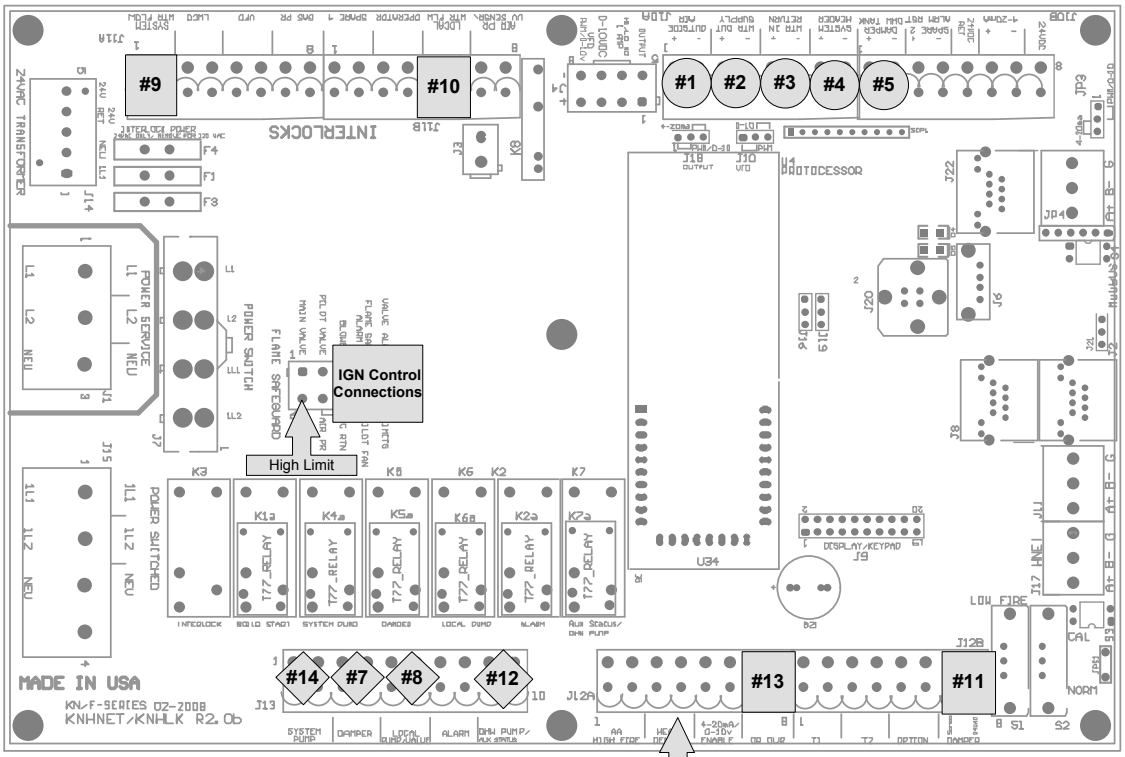


Figure 41 Typical Single Boiler System (version 2, green pc board, shown)





*Note: When using DHW MASTER? YES, a Heat Demand signal must be used to activate the system.

Figure 42 Using a 4–20ma signal for direct modulation

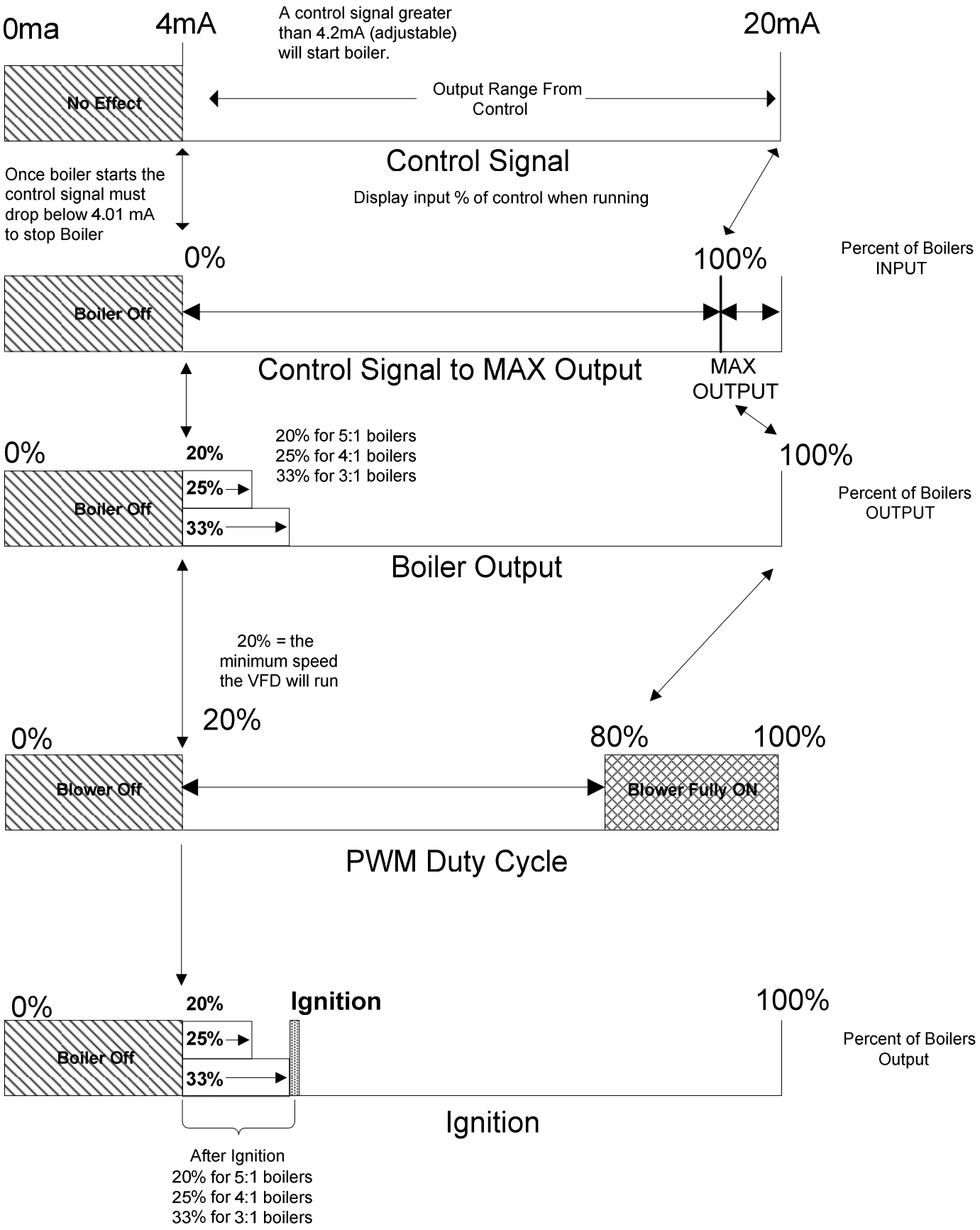


Figure 43 Common system damper wiring

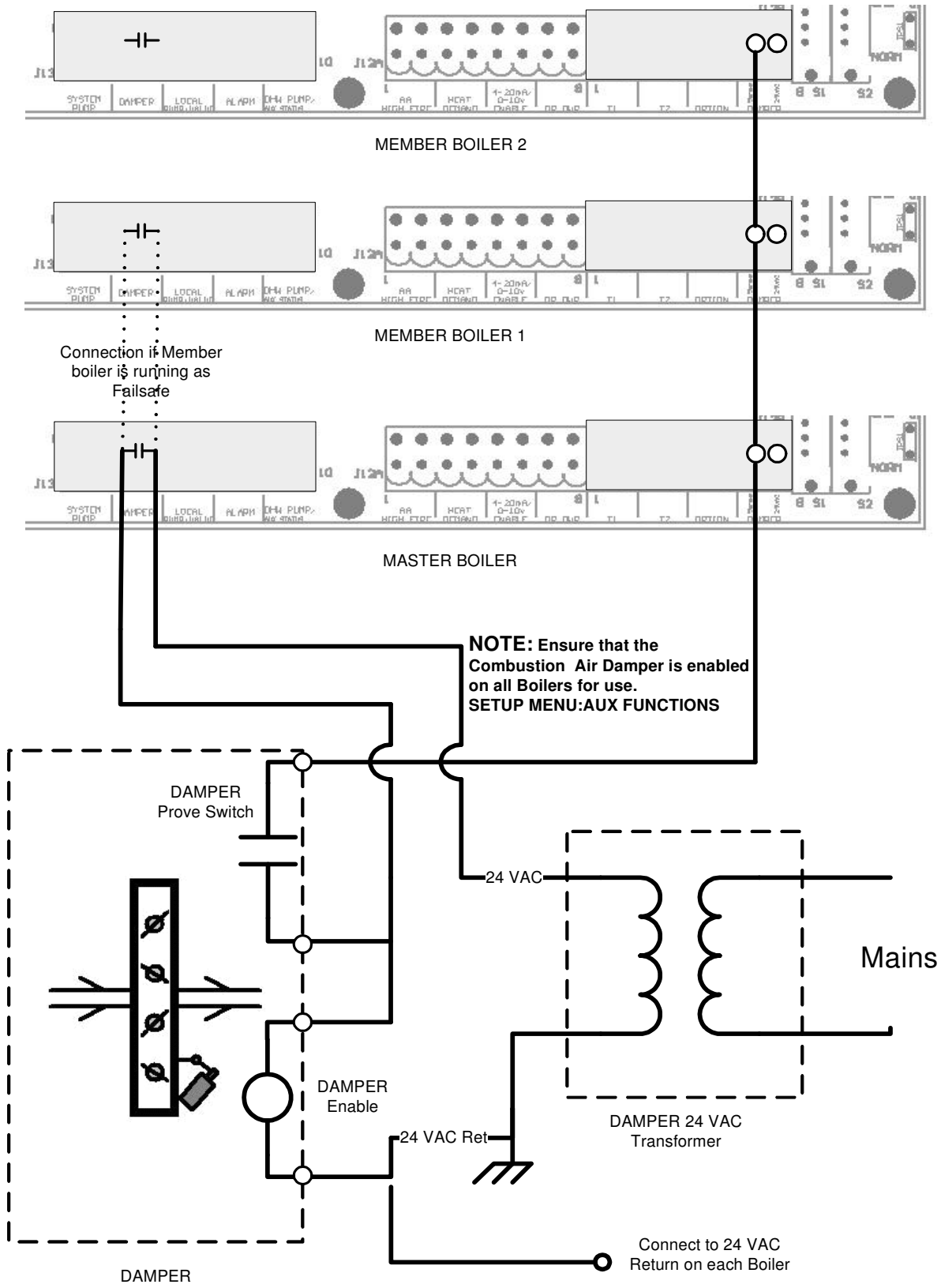
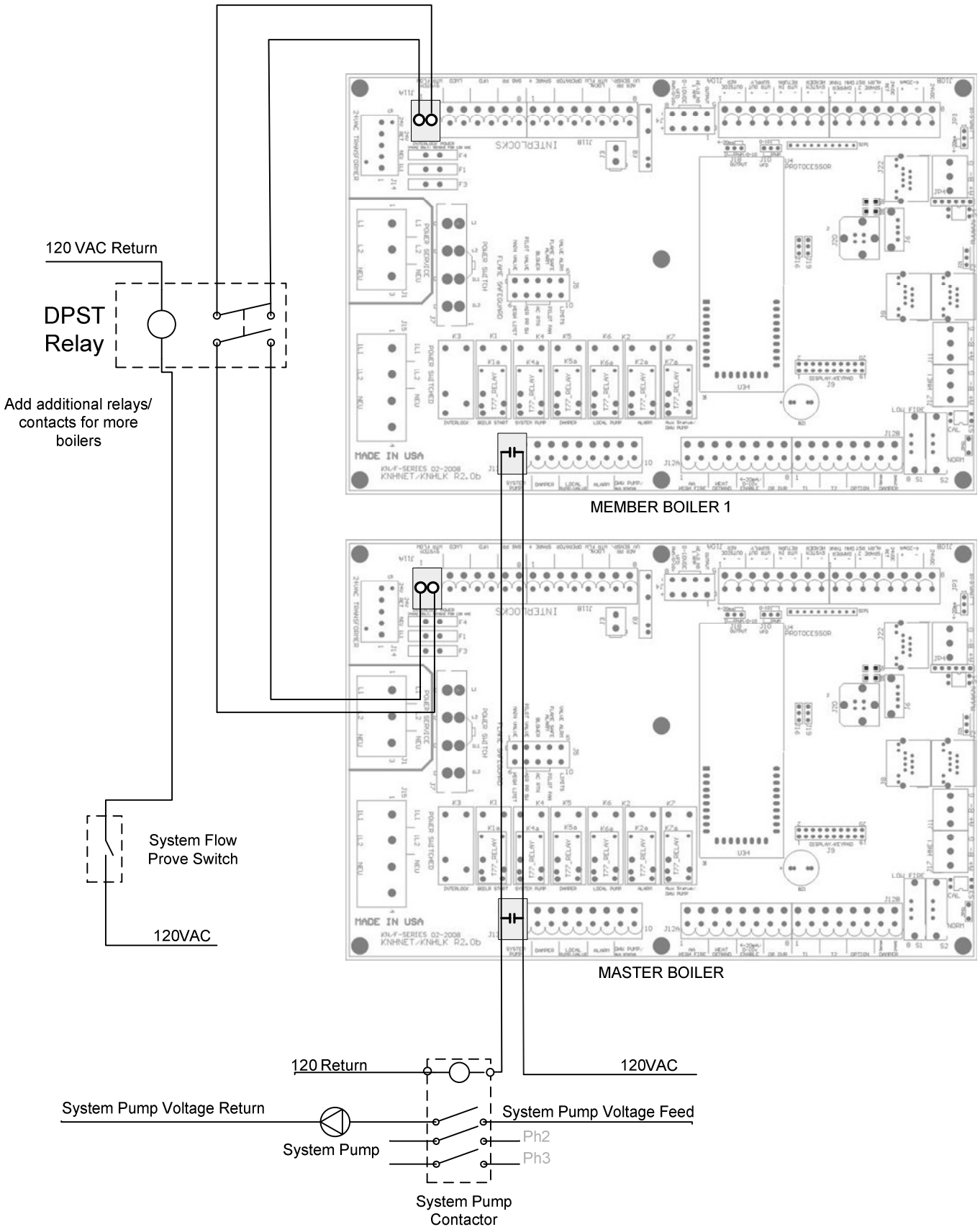

MEMBER BOILER 2
MEMBER BOILER 1
Connection if Member boiler is running as Failsafe
MASTER BOILER
NOTE: Ensure that the Combustion Air Damper is enabled on all Boilers for use.
SETUP MENU:AUX FUNCTIONS
DAMPER Prove Switch
24 VAC
Mains
DAMPER Enable
24 VAC Ret
DAMPER 24 VAC Transformer
Connect to 24 VAC Return on each Boiler
DAMPER

Figure 44 Failsafe common system pump wiring



Calibration

A detailed startup and walkthrough of the calibration and H-Net setup is provided in the Programming Examples manual.

NOTICE **The calibration of the KN-Series boiler should only be performed by a licensed technician**.

To enter the calibration menus, place the S2 switch on the main control board to the CAL position.

Be sure to set this switch back to NORM when the calibration is complete, otherwise no external control inputs will work (except T1-T2), the display will always indicate CALIBRATE and some of the runtime temperatures will not be displayed.

The MIN VFD setting, the MAX VFD setting, and the Ignition setting can be adjusted in the calibration displays. The values can be changed while running **ONLY IN MINIMUM FIRE** (any, but only one of the T inputs closed). Prior to ignition, the values may be changed, but the blower will not operate.

NOTICE If a version 2.0 control board is used, a Low Fire Hold switch is located near the Calibration switch.

Press the arrow keys until MIN VFD is shown in the display, along with the minimum percentage value at which the boiler is to run at min fire. While in Standby (no call for heat on inputs), the minimum percent may be preset. To set the minimum rate while running, any (1), and only (1) of the (T) inputs must be closed in order to set the boiler to MINIMUM fire. Press the SELECT key for approximately 1 second. The Percentage value will start flashing, indicating that it can be adjusted. Adjust the Minimum value to the desired setting using the arrow keys. The Minimum setting is clamped to its lowest rated setting and cannot be adjusted below this. Once you are done with this setting, press the SELECT key until the value stops flashing. The new setting is now saved.

Press the Arrow key to select the IGNITION percent. The Blower speed will be set here to provide the rate for ignition. While in Standby (no call for heat on inputs), the Ignition percent may be preset, before firing the boiler. To set the ignition rate while running, any (1), and only (1) of the T inputs must be closed Pressing the SELECT key here will cause the IGNITION setting to flash and the boiler will ramp to the ignition setting. Adjust it using the arrow keys and then press the SELECT key until the value stops flashing. The new setting is now saved.

Log Entry

The KN-Series H-Net control contains a log that records the major activity (events) in the operation of the boiler. This activity includes interlock faults, boiler starting and stopping events, power cycles, misc. faults, and types of calls-for-heat (control inputs). Setting the time clock to an accurate time and date is very useful when events are recorded, since the control will time stamp each snapshot. If the system is configured to run with HeatNet, then only the Master boilers SYSTEM TIME needs to be entered. The Master will then set the time on all Member boilers.

The log is primarily used as a troubleshooting and diagnostic tool, but may be used as a performance tool to view run time cycles.

An event in time of the boiler's state is presented via multiple screens. Each screen event can be stepped through using the arrow keys.

The top line displays the time and date the event occurred. In the top right corner, the event # is displayed so that easy indexing can be done using the arrow keys. The second line displays the Water temperature of the boiler's output (supply) and the Setpoint temperature. The third line displays the **O**utside **A**ir temperature, and the Modulation PWM signal sent to the Variable Frequency drive (20% =min, 80% =Max). The bottom line is used to record the control state of the boiler.

The control state is defined as the Boiler(s) that is running, the Circulator Pump state, and the ignition condition (Main Valve, Pilot Valve, Blower, and the Ignition alarm). The # of boilers that are displayed is limited to 7 if the boiler is the MASTER. If boilers #8 and up need to be viewed, the *Boiler Control Pro* software will need to be used. The Last 2 characters on the fourth line indicate the heating mode the control is in. The modes are:

NC = No Call for Heat

HD = Heat Demand (MASTER and Local modulation control using PID control, MASTER and MEMBER)

RM = Remote Modulation from 4-20ma input

HF = High Fire from ALL T-inputs closed or the AA input

1T = Low Fire from any 1 T-input closed (Low Fire or High Fire)

2T = Mid Fire from any 2 T-inputs closed (Low fire or High Fire)

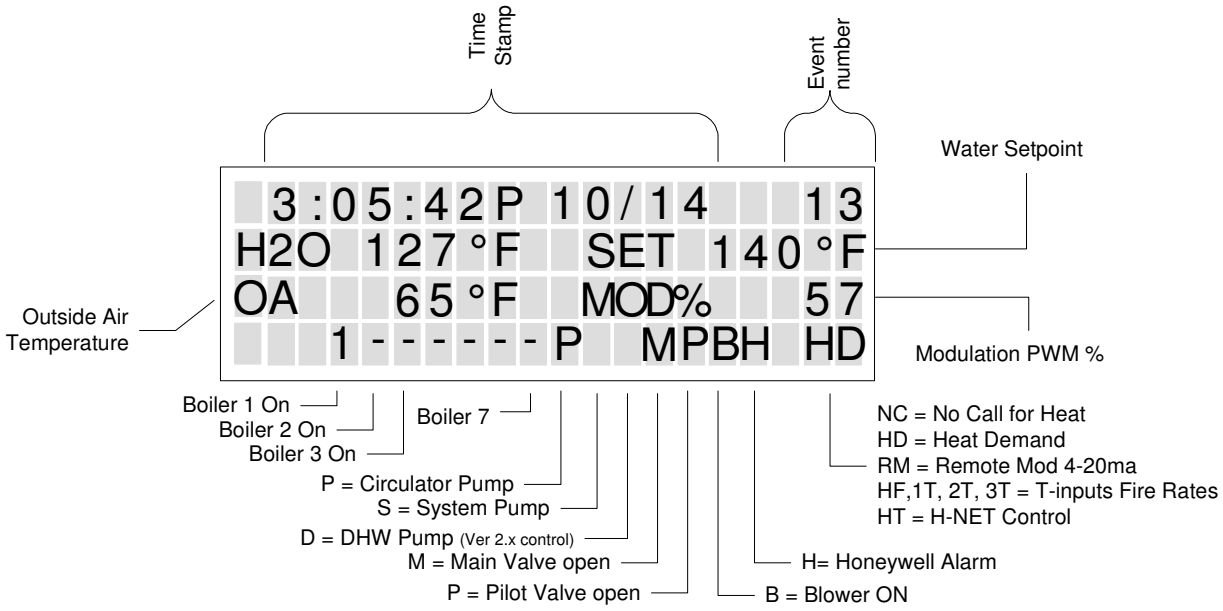
OP = Option input Active

HT = H-Net Control using the Heat-Link communications cable

The bottom line is also used to indicate an interlock or limit that has tripped. It may also indicate a sensor that has failed. When this occurs, the normal bottom line in the display is not visible, and the sensor fault is displayed.

For details on messages that appear on the fourth line: See *Appendix B*.

Figure 45 Log entry display



Default Settings & Menu Item Descriptions — SETUP

MENU	DEFAULT VALUE	RANGE	DESCRIPTION
BOILERS			
# OF BOILERS	1	(1-16)	If operating as a member.
LEAD BOILER #	0	(0-16)	# of first boiler to run, determines the fire order in rotation. A
LEAD BOILER #	0	(0-16)	# of first boiler to run, determines the fire order in rotation. A 0 disables the Lead Boiler function. Firing Mode determines lead.
HEAT BAND	30 °F	(2 -50 °F)	Differential temp around setpoint used to stage boiler(s) OFF/ON
HNT	M	(M-16)	This line displays the boilers auto detected by H-Net. While M is the Master boiler the numbers are the H-Net address of each boiler from 2–16.
SETPOINTS			
LOCAL SETPT	160 °F	(40-220 °F)	Local setpoint used to maintain temperature of SETPT SOURCE
OPERATE LIMIT	215 °F	(45-230 °F)	When running as a member, boiler shuts off when supply temperature reached. Boiler restarts at lower temp of OP LIM BAND or 10F whichever is lower
LOCAL SETPT	160 °F	(40-220 °F)	Local setpoint used to maintain temperature of SETPT SOURCE
OP LIM BAND	20 °F	(1-50 °F)	Limits external input % when in (OP LIM - OP LIM BAND)
SETPT SOURCE	AUTO	AUTO 4-20mA	AUTO = Local/ System/ WWS Setpoint is used 4-20mA input is mapped to a setpoint.
OUTDOOR AIR RESET			
OA RESET	OFF		Outdoor reset ratio (boiler water temp/outside air temp).
WARM WEATHER SD	NO		If set to YES, the boiler /system shuts down when the temperature exceeds the WWS SETPOINT.
WWS SETPOINT	68 °F	(40 – 100 °F)	Temperature at which boiler shuts down, operation is below this. If boiler is running using either OA RESET or WWS and the OA OVR input is closed the OA RESET slope is overridden and runs at local setpoint until OA OVR input opens.
SET OA SETPOINTS			
WATER TEMP At HIGH OA TEMP	140 °F	(60 – 150 °F)	Boiler water temp setpoint when OA temp is at HIGH OATEMP These four setpoints determine the OA reset slope.
WATER TEMP At LOW OA TEMP	10 °F	(-35 – 40 °F)	Header/Supply setpoint when OA Temp is at LOW OA TEMP
PUMP OPTIONS			
SYSTEM PUMP			
POST PRGE TIME	2 minutes	(2-60min)	Time in minutes to keep system circ. pump on after boiler stops
ALWAYS ENABLED	OFF	ON/OFF	ON = Pump never shuts off.
SUMMER PUMP JOG	OFF	ON/OFF MON-SUN	Used with Outdoor Reset, Jogs pump for POST PRGE time when system is in summer shutdown. Jog once a week @12:00 AM.
OVR ENAB IN WWS	OFF	ON/OFF	Priority mode for the system pump while in Warm Weather hutdown. ON: The system pump is allowed to run in WWS when the OR OVR override input is closed. When set to OFF, the system pump will not come on while in WWS with the OR OVR override input closed.
LOCAL PUMP			

DELTA TEMP ENAB	OFF		ON: Use Delta temperature to shut pump off when temperature across boiler is less than DELTA TEMP setting.
DELTA TEMP	10 °F	(2 – 50 °F)	
POST PRGE TIME	2 minutes	(1-60min)	Time in minutes to keep local circ. pump on after boiler stops
ALWAYS ENABLED	OFF		Pump never shuts off.
PUMP/VALVE OPTIONS			
MASTER PUMP/VALVE			
REMAINS ON:	OFF	ON/OFF	ON: The master boiler will keep its pump/valve on when no boilers are running. Prevents deadheading the system flow.
LOCAL PUMP VFD	OFF	ON/OFF	ON: Outputs a 0-10VDC or 4-20mA signal from J4 pins 1 & 5 that is proportional to the fire rate of the boiler. Connect to a VFDcontrolling a Local pump.
FLOW PROVE	10s	10-240 sec	This is an adjustable flow proving time to allow slower valves to open before proving flow.
NIGHT SETBACK			
SETBACK ENTRY	1	(1 – 4)	Four setbacks to adjust setpoint during a time period
ENTRY IS	OFF		Enable or disable the use of this setback
SETBACK	20 °F	(0 – 50 °F)	Temporarily subtracts this temp from the setpoint
START DAY	MON		Day of the week to begin setback or a day range
TIME	12:00AM		Time to begin setback
END DAY	MON		Day of the week to end the setback or a day range
TIME	12:00AM		Time of the day to end the setback
OPTIONS			
TEMP SCALE	° F	(F or C)	Fahrenheit scale is default
KEY CLICK	ON		Beeps when a key is pressed
SKIP PASSWORD	ON		Disables the Password
BRIGHTNESS	50%	(25, 50,75,100)	Four levels of display brightness, lower for longer life of the display
LOG/RUNTIME			
RUN HOURS			Displays runtime hours. Total time the main valve has been open.
DATA LOG ENTRY			Displays the current entry in the data log
SIZE			Displays the current size of the log in entries
BOILER CYCLES			Displays completed boiler cycles. Incremented when the main valve turns OFF after it has been ON. Does not include attempts to light.

AUX FUNCTIONS			
COMBUST AIR DAMPER			
		LINKED/COMMON INDEPENDENT	The LINKED/COMMON setting allows one common damper to be used and controlled by the Master Boiler. All Member boilers must have their damper prove inputs wired as per Figure 43, Common system damper wiring, page 48. Also see Section: *Optional Features: Auxilliary Function Options* INDEPENDENT: Individual dampers are in controlled by their respective boiler.
IN USE?	YES		If set to YES, then OUTPUT RELAY K5 can be used to control a combustion air damper. The Master can control a common system damper or an individual damper. Members control their respective damper independent of the Master. Relay K5 is used to enable the combustion air damper. See Figure 43, Common system damper wiring, page 48. Needs to Prove the damper is open.
INPUT:	J10B DAMPER		There are (2) inputs that may be used for the Combustion Air Damper. The first is located at J10B terminals 1 and 2 (legacy compatibility). The second input is located at J12B terminals 7 and 8.
PROOF TIME	2:00	(0 – 4min)	This is the proving time in minutes for the combustion air damper prove switch. It is sensed at SPARE 1 on J10B or J12B Pin 7. If J10B is used (legacy), Sensor #5 must be set to ON/OFF in the sensors menu in order to detect the prove switch being made. If the damper faults, a retry will occur every 10 minutes in attempt to open the damper. If Using J12B in a common damper configuration, wiring is done beginning with the Master boiler. J12B Pins 7,8 are connected to the prove switch of the combustion damper. Pin 8 is supplying 24 VAC and pin 7 is the sense input. A second wire is connected to J12B pin 7 of the Master and the other end connected to the first member boilers J12B pin 7. If another member boiler is present, connect another wire to the J12B Pin 7 terminal of the first member and the other end to the second member boiler J12B pin 7. Continue this method for each additional boiler.
ALARM SILENCE			
ALARM SILENCE IN USE?	YES		This menu allows the configuration of the Alarm Silence switch. It can be disabled so that the Alarm Silence switch can not silence the alarm until the alarm is cleared; ALARM SILENCE = NO. The default value is to enable the ALARM SILENCE switch.
INPUT =	J10B SPARE 2		This setting allows the Alarm Switch to be looked at using another input. This input should not be changed, but allows for custom configurations to resolve conflicts.
FAILSAFE MODES			
RUN IN LOCAL IF: H-NET COMM LOST	OFF		If this entry is set to ON and the Member boiler does not see any communications coming from the Master boiler, this boiler will run in LOCAL. The boiler will continue to run in LOCAL until communications is re-established or this entry is set to OFF.
LOW TEMP	OFF		This entry may be set to one of the temperature sensors: SUPPLY, HEADER, RETURN, or turned OFF (default). If this entry is set to a sensor and the temperature falls below TEMP, the boiler will automatically start and run the water temperature up to the LOCAL Setpoint and then shut OFF.
TEMP < 40F	40 °F	35-200 °F	This is the temperature that the selected sensor must fall below for the boiler to start.

MENU	DEFAULT VALUE	RANGE	DESCRIPTION
HEAT EXCHANGER			
EXCHR DELTA T	100 °F	1 to 120 °F	This is the maximum differential temperature the heat exchanger can see before the LIMIT RATE feature is activated, and a log entry is made.
LIM-> HALF RATE	YES		Limit to Half Rate: When set to YES, and the maximum differential temperature (delta T) has been exceeded, the fire rate called for is cut in half. In other words: if we are calling for 80% modulation and have exceeded the delta T, the boiler will only fire at 40%. The delta T needs to drop 10F below the maximum delta T to reset this limit. The message " ½ INPUT" will be displayed on a member boiler and a Master Boiler will display the Modulation % for the system even though it is running at ½ of this rate. This method helps protect the heat exchanger from damage due to excessive delta T's. If this Master boiler is running
DOMESTIC HOT WATER *(Version 2.x control)*			
DHW BOILER?	NO		Setting this value to YES enables the Boiler/System for DHW operation. DHW settings are only looked at if set to YES.
DHW SETPOINT	160 °F	40 – 200 °F	Setpoint that the boiler/system will target when a call for DHW.
DHW DIFF	5 °F	1 – 30 °F	DHW SETPOINT – DHW DIFF : if DHW water temperature is less than this temperature, the Boiler/System will enter DHW Heating mode. Once the DHW SETPOINT is reached, DHW mode is exited.
USE SENSOR?	NO		If this entry is set to YES, the DHW 10k Sensor is looked to for controlling DHW water temperature. If set to NO, A thermostat is used.
DHW PRIORITY	NO		If the DHW PRIORITY is set to YES, then when there is a call for DHW, the system pump shuts off. If NO, the system pump stays on.
POST PURGE	120s	0-600 secs	This is the time that the DHW relay remains on after the DHW call ends.
DHW MASTER?	NO		This parameter can only be used if USE SENSOR? is set to YES, and there is NO Header sensor Present.. If set to YES, this boiler becomes the DHW Master Boiler and will use HeatNet to control member boilers based on the DHW Sensor, DHW SETPOINT, and DHW DIFF. If set to NO, only this boiler will run in DHW mode.
SYSTEM CLOCK			
TIME			This time needs to be entered at first turn-on and in the event that power has been lost for more than 3 days. The time is only required for an accurate log entry time-stamp and fault time stamp.
DAY OF WEEK			
MONTH			
DAY			
YEAR			
PRESS SEL TO SAVE			The SEL key must be pressed after all time values have been entered to save all time values at once.

Default Settings & Menu Item Descriptions — ADVANCED SETUP

DISTRIBUTED CTRL			
CONTROL	H-Net		Displays method of operation: HeatNet (H-Net)
H-Net MASTER	YES		Auto detected, based on the HEADER sensor. If the HEADER sensor is present and is set to TYPEZ, the KN-Series control is run as a H-Net MASTER (YES). If the HEADER sensor is not TYPEZ, H-Net MASTER = NO.
H-NET ADDRESS	255	(2 –16)	The local address is the address of a member device. This is normally in the range of 2 through 16. But if the KN-Series control is a MASTER, then the default address is 255. The H-NET ADDRESS # is synonymous with boiler #.
MODBUS ADDRESS	1	(1 – 247)	The MODBUS address is for communicating with Laptop, PC, or other MODBUS capable device. It is the 2nd communication port reserved for host control.
MODULAR BOILER SET			
ADD BOILER DELAY	10mins	(0 – 15min)	This is the delay time in 30sec intervals, before starting a new boiler. Boiler #1 is started immediately after a call for heat. If a second boiler needs to start, the ADD BOILER DELAY will need to expire before starting.
SHED BOILER DELAY	2mins	(0-15min)	This is the delay time in 30 second intervals, before stopping a boiler. A boiler is stopped immediately when the top of the heat band is exceeded. If a second boiler needs to stop, the SHEDBOILER DELAY will need to expire before stopping.
MODULATE DELAY TIME	10 secs	(0 – 60min)	This is the time the boiler remains in min-fire before it relinquishes control to the modulation % signal.
MOD MAX – LAST FIRE	70%	(25 – 100%)	This value represents the maximum % of input on the boilers if all the available boilers are not firing. Once all boilers are firing, this clamp is removed and all boilers are allowed to modulate up to 100%. When this value is limiting the input an '*' is displayed and the "INPUT CLAMP" message is displayed in the STATUS screen. This value is derived by: multiplying twice the minimum fire rate of the boiler with the least turndown (2* turndown(20% 5:1, 25% 4:1, 33% 3:1)). In mixed boiler size configurations, more than (2) boilers in a system, or when "bumps" in the temperature occur as boilers are added and subtracted, this value may need adjustment. The adjustments will help produce smooth temperature control when each boiler is started and stopped. This method ensures that, once a new boiler starts to fire, and holds its fire rate at the minimum setting, it does not add its BTU output to a boiler already firing at 100%. The boilers can not be fired starting @ 0%, but start at a minimum (example: 20%) and introduce a minimum amount of BTUs into the system. Section: SETUP & OPERATION

ADAPTIVE MOD			
MOD MODE	ADAPTIVE		If MODulation MODE is set to ADAPTIVE on the Master boiler, the Master lowers the system modulation rate of all currently running boilers before a newly started boiler enters the Main Valve state. Upon entering the Main Valve state of a newly fired boiler, the Master waits the DELAY RELEASE time before allowing the PID to resume modulation control. With MOD MODE set to ORIG KN, The Master boiler keeps firing at the current modulation rate when a new boiler is added and lets the PID adjust modulation rate accordingly.
DROP DOWN	ON CALL		If drop down is set to ON PILOT and MOD MODE = ADAPTIVE, and when a newly added boiler starts, the system waits until it enters its PILOT state before bring the system modulation down. This allows for the system to prepare for the new energy that is to be introduced. If DROP DOWN is set to immediately, the system modulation is lowered as soon as the newly added boiler is called.
DELAY RELEASE	0s		Once the Main Valve opens on the newly added boiler and the MOD MODE = ADAPTIVE the Master waits this amount of time before releasing the PID to control modulation. This allows for the newly added boiler to accumulate some soak time.
FIRING MODE			
MODE	TRUE		LOFO: Boilers are fired Last On, First Off starting with Lead Boiler FOFO: Boilers are fired First On, First Off TRUE: Boilers are fired based on the runtime they report back to the Master boiler. Boilers with the least runtime are fired first and boilers with the most runtime are stopped first. MIXED: Different types of boilers can be mixed in a system and fired based on (2) Priority sets. Boilers are started and stopped with in the Priority sets based on their runtime hours.
MIN RUNTIME	10	(1-255)	When the firing rotation is based on runtime, this value represents the interval in hours of runtime before rotation occurs. Boiler to Boiler.
MIN OFF TIME	0	(0-10m)	This is the time in minutes that the boiler must remain OFF before it can be fired again.
PREDICT START:	YES	YES/NO	YES: Predicts the boiler restart point in the heating band while the temperature of the boiler is drifting down through the band. The purpose of this is to ensure the temperature remains in the temperature band. It also minimizes temperature swings when the boiler is stopped and started at low inputs.

BASE LOAD BOILERS *(Version 2.x control)*			
BASE LOAD BOILERS:	0	0-1	This setting works in conjunction with the ADVANCED SETUP: SYSTEM:OPTION setting BASE LOAD. Currently only (1) base load boiler is supported using relay K8 on the Version 2.x control.
START	>MOD	(START>MOD, START<OA T, START>RET)	Used in Conjunction with DELAY TIME.
START>MOD	100%	(20–100)	The base load relay K8 will close when the Modulation is >%.
START<OA T		(40–140)	The base load relay K8 will close when the OA temp is > T
START>RET		(60–150F)	The base load relay K8 will close when the Return temp is > T.
STOP	FIRST	(FIRST, STOP<MOD, START>OA T, START>RET)	
STOP<MOD	20% (20–100)	20% (20–100)	The base load relay K8 will open when the Modulation is <%.
STOP>OA T		(40–100 °F)	The base load relay K8 will open when the OA temp is > T.
STOP<RET		(60–150 °F)	The base load relay K8 will open when the Return temp is < T.
DELAY TIME	0	(0–60 minutes)	This setting allows a wait time before firing the base load boiler once the start condition is met.
SENSORS			
NOTICE Sensors can only be changed when there is no call for heat. The boiler must be in STANDBY.			
SENSOR #			The first (4) sensor #'s are reserved as: OUTSIDE AIR, water SUPPLY outlet, water RETURN inlet, and system HEADER temperature. If the HEADER sensor is used (TYPEZ), that boiler performs the tasks of the MASTER boiler. If the HEADER sensor is set to NONE, its function is the MEMBER. The remaining (2) sensors perform as user selections and provide functions such as: Combustion Air Proving.
TYPE			There are (4) sensor types: NONE = do not use this sensor TYPEZ = 10k thermistor ON/OFF = 5 volts supplied out to detect a contact/switch closure.
CALIBRATE			Placing a precision 10k (TYPEZ) precision resistor across the sensor input selected allows calibration of the sensor input.
4–20mA INPUT			
4mA SETPOINT	50 °F	50-220 °F	When using 4-20mA setpoint control in SETPOINTS:SETPOINT SOURCE. This is the temperature when a 4ma signal is applied and is tied to the BOILER START mA. The Setpoint will then be mapped from 4mA –20mA and example default of: 50-220F
20mA SETPOINT	220 °F	50-220 °F	This is the setpoint temperature when a 20mA signal is applied.
BOILER START	4.11mA	3.71-5.0mA	This is the current value which will start the boiler. There is a .1mA hysteresis value. So if the Boiler starts at 4.11mA it shuts off a 4.01mA.
PRIORITY	NORMAL		If the Priority is set to NORMAL, the boiler responds to its HEAT DEMAND inputs in the Priority that is outlined in the Control Methods section. If the PRIORITY is set to HIGHEST, The 4-20ma input responds at the highest Priority level (same as the AA input). This method may be used by an external control to override the HeatNet control and fire the boiler using this external control (external control override). This allows for complex DHW control systems.

PASSWORD			
	AAAAAA		Provides a limited access for security, though restoring system defaults will reset the password to the value “AAAAAA”
COMMUNICATIONS			
BAUD	19200	1200, 2400, 4800, 9600, 19200, 38400	This is the Baud rate for serial communication from the MODBUS port. Selectable from 1200, 2400, 4800, 9600, 19200, 38400.
DATA FORMAT	8E1	8E1, 8N1, 8N2, 8O1	8 bits -Even Parity -1 stop bit, valid settings: 8E1, 8N1, 8N2, 8O1
SETPOINT TIMER	YES		If set to ‘YES”, the setpoint timer is enabled and requires a periodic update of its value to keep from timing out and retuning control to H-Net control. If set to “NO”, MODBUS always has control and on a loss of MODBUS communications, H-Net does not assume control.
LOAD DEFAULTS			
FACTORY CAL?			Selecting YES will load just the factory calibration values: MIN VFD, MAX VFD and IGN VFD.
FACTORY RESET?	NO		Selecting YES will load all factory defaults except the Calibration values, HeatNet, and Modbus addresses.
SYSTEM			
BOILER TYPE			
FIRING PRIORITY:	2	1 or 2	There are (2) Priority settings used by the MIXED boiler rotation algorithm. Priority 2 is the default and lowest priority. Priority 1 isthe
BTU IN	2000,000		This is the BTU input rating of the boiler. This value is not used with this version and is displayed only for reference.
CONDENSING	YES		This defines a boiler as condensing or non-condensing. This value is not used with this version and is displayed only for reference and future applications.
MASS			This defines the mass of the boiler. This value is not used with this version and is displayed only for reference and future applications.
LOAD FIRMWARE	NO		Answering YES deletes the existing Firmware and allows a firmware update.
OPTION:	NO OPTION	NO OPTION DUAL FUEL BASE LOAD	When set to DUAL FUEL, input T3/ RESERVED, OPTION input is used to control the DUAL FUEL OPTION relay via K8 contacts on J4.2 &.6. When set to NO OPTION the input T3/RESERVED, OPTION relay K8 on J4.2 &.6 is inactive. When set to BASE LOAD, the Option Relay K8 on J4.2 &.6 is used as an enable contact for a base load boiler. The J4.1 &.5 0-10vdc/4-20mA output is used to modulate the base load relay if it is of the modulating type.

MODBUS Communications

The KN-Series control can be controlled using Modbus commands to Enable/Disable the boiler/system. A connection to the Console Modbus Port on the Communications board is required. The Master Boiler assumes the role of MEMBER, RTU, 192Kb, 8 bits, Even Parity, 1 stop bit, when connected to a BMS (Building Management System).

The Member Boilers should not be connected to a BMS system other than to view Read Only addresses. Refer to http://www.hydrothermkn.com/ website for greater detail on communicating with Modbus, BACnet, or LonWorks protocols.

Figure 46 MODBUS Input/Output Variables (Read/Write)

Address	Name	Raw Data Type	Scale	Description	Valid Values/Range
40001	HeatDemand	1 bit unsigned	---	Heat Demand/Request. Setting the state member of this variable will put the boiler in heating mode.	0 = no heat demand 1 = heat demand
40002	SetpointTimer	16 bit unsigned	---	System Setpoint Timer The system setpoint timer and system setpoint work in tandem to externally control (i.e. a BMS - building management system) the operating setpoint. The setpoint (countdown) timer should be loaded with a timeout value (in seconds) prior to writing the system setpoint. When the timer reaches zero, the control assumes that the BMS is no longer operating and the local setpoint (saved on the control) is reloaded. This is a failsafe feature used to help safeguard the system in case of BMS failure. If the setpoint timer is not written, a default timeout value of 60 seconds is assumed.	0 – 65535 seconds
40003	Setpoint	8 bit unsigned	1.0	System Setpoint (see *SetpointTimer*)	40 - 220 °F
40004	OAResetEnable	1 bit unsigned	---	Enables/Disables outdoor air reset mode.	0 = disabled 1 = enabled
40005	OARSetpoint	8 bit unsigned	1.0	Outdoor air reset setpoint. Temperature at which boiler shuts down.	40 – 100 °F
40006	OARHighWaterTemp	8 bit unsigned	1.0	Boiler water temperature setpoint when outdoor air temperature is at the high outdoor air temperature setpoint (OARHiAirTemp).	60 – 150 °F
40007	OARHighAirTemp	8 bit unsigned	1.0	High outdoor air temperature setpoint.	50 – 90 °F
40008	OARLowWaterTemp	8 bit unsigned	1.0	Header/Supply temperature setpoint when outdoor air temperature is at the low outdoor air temperature setpoint (OARLoAirTemp).	70 – 220 °F
40009	OARLowAirTemp	8 bit signed	1.0	Low outdoor air temperature setpoint.	-35 – 40 °F
40010	SetMonth	8 bit unsigned	---	Set real time clock – month (*see SetClock*)	0 (January) - 11 (December)
40011	SetDay	8 bit unsigned	---	Set real time clock – day (*see SetClock*)	1 – 31
40012	SetYear	8 bit unsigned	---	Set real time clock – year (*see SetClock*)	0 – 99
40013	SetHour	8 bit unsigned	---	Set real time clock – hour (*see SetClock*)	0 – 23
40014	SetMinute	8 bit unsigned	---	Set real time clock – minute (*see SetClock*)	0 – 59

Figure 46 MODBUS Input/Output Variables (Read/Write)					
Address	**Name**	**Raw Data Type**	**Scale**	**Description**	**Valid Values/Range**
40015	SetSecond	8 bit unsigned	---	Set real time clock – second (*see SetClock*)	0 – 59
40016	SetWeekday	8 bit unsigned	---	Set real time clock – weekday (*see SetClock*)	1 (Monday) - 7 (Sunday)
40017	SetClock	1 bit unsigned	---	Set (write) the real time clock. Do Not Write more than once per minute To write the real time clock, the system variables (SetMonth, SetMonth, SetDay, SetYear, SetHour, SetMinute, SetSecond, SetWeekday) must first be loaded with the correct date and time. Then, a 1 must be written to the state portion of this system variable to write the new date and time to the system clock.	0 = no action 1 = set/write the clock

Figure 47 MODBUS Input Variables (Read Only)					
Address	**Name**	**Raw Data Type**	**Scale**	**Description**	**Valid Values/Range**
30001	BoilersOn	8 bit unsigned	---	The number of boilers currently running.	0 – 16
30002	Modulation	8 bit unsigned	0.01	Current system modulation level.	0 – 100 %
30003	HeaderTemp	16 bit signed	0.01	Header / System temperature.	32 – 250 °F
30004	SupplyTemp	16 bit signed	0.01	Supply temperature.	32 – 250 °F
30005	ReturnTemp	16 bit signed	0.01	Return temperature.	32 – 250 °F
30006	OutsideTemp	16 bit signed	0.01	Outside air temperature.	-40 – 250 °F
30007	Spare1	16 bit signed	---	Raw A/D value from spare 1 input.	-32768 to 32767
30008	Spare2	16 bit signed	---	Raw A/D value from spare 2 input.	-32768 to 32767
30009	Month	8 bit unsigned	---	Real time clock month.	0 (January) - 11 (December)
30010	Day	8 bit unsigned	---	Real time clock day.	1 – 31
30011	Year	8 bit unsigned	---	Real time clock year.	0 – 99
30012	Hour	8 bit unsigned	---	Real time clock hour.	0 – 23
30013	Minute	8 bit unsigned	---	Real time clock minute.	0 – 59
30014	Second	8 bit unsigned	---	Real time clock second.	0 – 59
30015	Weekday	8 bit unsigned	---	Real time clock weekday.	1 (Monday) – 7 (Sunday)
30016	Boiler01Status1	16 bit unsigned	---	Boiler (1 – 16) status flags. These bits indicate the state of the 24VAC interlocks, ignition circuit, and various other conditions. See the values column for a list of conditions. Boiler01 = Master Boiler02 = Member01 … Boiler16 = Member15	See the “BoilerStatus1” and “BoilerStatus2” Tables below.
30017	Boiler01Status2				
30018	Boiler02Status1				
30019	Boiler02Status2				
30020	Boiler03Status1				
30021	Boiler03Status2				
30022	Boiler04Status1				
30023	Boiler04Status2				
30024	Boiler05Status1				

Figure 47 MODBUS Input Variables (Read Only)

Address	Name	Raw Data Type	Scale	Description	Valid Values/Range
30025	Boiler05Status2				
30026	Boiler06Status1				
30027	Boiler06Status2				
30028	Boiler07Status1				
30029	Boiler07Status2				
30030	Boiler08Status1				
30031	Boiler08Status2				
30032	Boiler09Status1				
30033	Boiler09Status2				
30034	Boiler10Status1				
30035	Boiler10Status2				
30036	Boiler11Status1				
30037	Boiler11Status2				
30038	Boiler12Status1				
30039	Boiler12Status2				
30040	Boiler13Status1				
30041	Boiler13Status2				
30042	Boiler14Status1				
30043	Boiler14Status2				
30044	Boiler15Status1				
30045	Boiler15Status2				
30046	Boiler16Status1				
30047	Boiler16Status2				
30048	Boiler01RuntimeHigh16	16 bit unsigned	---	Boiler (1 – 16) Runtime seconds High (Upper) and Low (Lower) 16 bit counters. To get the actual runtime for any given boiler (##), the high and low 16 bit counters must be combined (concatenated) into a single 32 bit counter as: Boiler##RuntimeHigh16:Boiler##RuntimeLow16 Example Boiler01Runtime = (Boiler01RuntimeHigh16 * 65536) + Boiler01RuntimeLow16 Boiler01 = Master Boiler02 = Member01 … Boiler16 = Member15	0 – 4294967295 seconds
30049	Boiler01RuntimeLow16				
30050	Boiler02RuntimeHigh16				
30051	Boiler02RuntimeLow16				
30052	Boiler03RuntimeHigh16				
30053	Boiler03RuntimeLow16				
30054	Boiler04RuntimeHigh16				
30055	Boiler04RuntimeLow16				
30056	Boiler05RuntimeHigh16				
30057	Boiler05RuntimeLow16				
30058	Boiler06RuntimeHigh16				
30059	Boiler06RuntimeLow16				
30060	Boiler07RuntimeHigh16				
30061	Boiler07RuntimeLow16				
30062	Boiler08RuntimeHigh16				
30063	Boiler08RuntimeLow16				
30064	Boiler09RuntimeHigh16				

Figure 47 MODBUS Input Variables (Read Only)					
Address	**Name**	**Raw Data Type**	**Scale**	**Description**	**Valid Values/Range**
30065	Boiler09RuntimeLow16				
30066	Boiler10RuntimeHigh16				
30067	Boiler10RuntimeLow16				
30068	Boiler11RuntimeHigh16				
30069	Boiler11RuntimeLow16				
30070	Boiler12RuntimeHigh16				
30071	Boiler12RuntimeLow16				
30072	Boiler13RuntimeHigh16				
30073	Boiler13RuntimeLow16				
30074	Boiler14RuntimeHigh16				
30075	Boiler14RuntimeLow16				
30076	Boiler15RuntimeHigh16				
30077	Boiler15RuntimeLow16				
30078	Boiler16RuntimeHigh16				
30079	Boiler16RuntimeLow16				
30080	Boiler01Status3	16 bit unsigned	---	Boiler (1 – 16) stage control input flags. These bits indicate the state of the stage control inputs. See the values column for a list of conditions.	See the “BoilerStatus3” Table below.
30081	Boiler02Status3				
30082	Boiler03Status3				
30083	Boiler04Status3				
30084	Boiler05Status3				
30085	Boiler06Status3				
30086	Boiler07Status3				
30087	Boiler08Status3				
30088	Boiler09Status3				
30089	Boiler10Status3				
30090	Boiler11Status3				
30091	Boiler12Status3				
30092	Boiler13Status3				
30093	Boiler14Status3				
30094	Boiler15Status3				
30095	Boiler16Status3				
----- The following registers are available starting in firmware version 2.0 -----					
30096	Boiler01SupplyTemp	16 bit signed	0.01	Boiler (1 – 16) supply temperature (if available). See BoilerStatus2 to determine if the sensor is present. Boiler01 = Master Boiler02 = Member01 … Boiler16 = Member15	32 – 250 °F
30097	Boiler02SupplyTemp				
30098	Boiler03SupplyTemp				
30099	Boiler04SupplyTemp				
30100	Boiler05SupplyTemp				
30101	Boiler06SupplyTemp				
30102	Boiler07SupplyTemp				
30103	Boiler08SupplyTemp				

Figure 47 MODBUS Input Variables (Read Only)					
Address	**Name**	**Raw Data Type**	**Scale**	**Description**	**Valid Values/Range**
30104	Boiler09SupplyTemp				
30105	Boiler10SupplyTemp				
30106	Boiler11SupplyTemp				
30107	Boiler12SupplyTemp				
30108	Boiler13SupplyTemp				
30109	Boiler14SupplyTemp				
30110	Boiler15SupplyTemp				
30111	Boiler16SupplyTemp				
30112	Boiler01ReturnTemp	16 bit signed	0.01	Boiler (1 – 16) return temperature (if available). See BoilerStatus2 to determine if the sensor is present. Boiler01 = Master Boiler02 = Member01 … Boiler16 = Member15	32 – 250 °F
30113	Boiler02ReturnTemp				
30114	Boiler03ReturnTemp				
30115	Boiler04ReturnTemp				
30116	Boiler05ReturnTemp				
30117	Boiler06ReturnTemp				
30118	Boiler07ReturnTemp				
30119	Boiler08ReturnTemp				
30120	Boiler09ReturnTemp				
30121	Boiler10ReturnTemp				
30122	Boiler11ReturnTemp				
30123	Boiler12ReturnTemp				
30124	Boiler13ReturnTemp				
30125	Boiler14ReturnTemp				
30126	Boiler15ReturnTemp				
30127	Boiler16ReturnTemp				
30128	Boiler01CyclesHigh16	16 bit unsigned	---	Boiler (1 – 16) Cycles High (Upper) and Low (Lower) 16 bit counters. To get the actual cycle count for any given boiler (##), the high and low 16 bit counters must be combined (concatenated) into a single 32 bit counter as: Boiler##CyclesHigh16:Boiler##CyclesLow16 Example Boiler01Cycles = (Boiler01CyclesHigh16 * 65536) + Boiler01CyclesLow16 Boiler01 = Master Boiler02 = Member01 … Boiler16 = Member15	0 – 4294967295
30129	Boiler01CyclesLow16				
30130	Boiler02CyclesHigh16				
30131	Boiler02CyclesLow16				
30132	Boiler03CyclesHigh16				
30133	Boiler03CyclesLow16				
30134	Boiler04CyclesHigh16				
30135	Boiler04CyclesLow16				
30136	Boiler05CyclesHigh16				
30137	Boiler05CyclesLow16				
30138	Boiler06CyclesHigh16				
30139	Boiler06CyclesLow16				
30140	Boiler07CyclesHigh16				
30141	Boiler07CyclesLow16				
30142	Boiler08CyclesHigh16				
30143	Boiler08CyclesLow16				

Figure 47 MODBUS Input Variables (Read Only)					
Address	**Name**	**Raw Data Type**	**Scale**	**Description**	**Valid Values/Range**
30144	Boiler09CyclesHigh16				
30145	Boiler09CyclesLow16				
30146	Boiler10CyclesHigh16				
30147	Boiler10CyclesLow16				
30148	Boiler11CyclesHigh16				
30149	Boiler11CyclesLow16				
30150	Boiler12CyclesHigh16				
30151	Boiler12CyclesLow16				
30152	Boiler13CyclesHigh16				
30153	Boiler13CyclesLow16				
30154	Boiler14CyclesHigh16				
30155	Boiler14CyclesLow16				
30156	Boiler15CyclesHigh16				
30157	Boiler15CyclesLow16				
30158	Boiler16CyclesHigh16				
30159	Boiler16CyclesLow16				

Figure 48 MODBUS — BoilerStatus Flags		
Bit	**Description**	**Valid Values/Range**
0	Pilot Valve	0 = closed, 1 = open
1	Blower Running	0 = off, 1 = running
2	Ignition Alarm	0 = ok, 1 = alarm
3	Valve Alarm	0 = ok, 1 = alarm
4	High Limit	0 = ok, 1 = tripped
5	Air Prove Switch	0 = open, 1 = closed
6	RESERVED (FACTORY)	
7	Software Operator	0 = off, 1 = on
8	Header Sensor not Detected	0 = detected, 1 = not detected
9	Supply Sensor not Detected	0 = detected, 1 = not detected
10	Return Sensor not Detected	0 = detected, 1 = not detected
11	Outside Sensor not Detected	0 = detected, 1 = not detected
12	System Pump	0 = off, 1 = on
13	Combustion Air Damper	0 = off, 1 = on
14	Master Boiler	0 = member, 1 = master
15	Boiler Detected (at this address)	0 = not detected, 1 = detected

Figure 49 MODBUS — BoilerStatus2 Flags		
Bit	**Description**	**Valid Values/Range**
0	Disabled	0 = enabled, 1 = disabled
1	Heat Demand	0 = no demand, 1 = demand (1)
2	Alarm	0 = ok, 1 = alarm
3	Failed	0 = ok, 1 = failed
4	Member Error	0 = ok, 1 = error
5	Boiler Running	0 = off, 1 = running
6	Pump Running	0 = off, 1 = running
7	Spare 3 Interlock	0 = open, 1 = closed
8	LWCO Interlock	0 = open, 1 = closed
9	VFD Interlock	0 = open, 1 = closed
10	Gas Prove Interlock	0 = open, 1 = closed
11	Spare 4 Interlock	0 = open, 1 = closed
12	Operator Interlock	0 = open, 1 = closed
13	Water Prove (Flow) Interlock	0 = open, 1 = closed
14	UV Sensor Air Prove Interlock	0 = open, 1 = closed
15	Main Valve	0 = closed, 1 = open

This BoilerStatus2 Heat Demand Flag is a combination of the Heat Demand input and the Modbus Heat Demand (40001).

Figure 50 MODBUS — BoilerStatus3 Flags		
Bit	**Bit**	**Bit**
0	AA High Fire	0 = off, 1 = on
1	Heat Demand (Local Override)	0 = off, 1 = on (1)
2	4-20ma Remote Enable	0 = off, 1 = on
3	Outdoor Air Reset Override	0 = off, 1 = on
4	T1	0 = off, 1 = on
5	T2	0 = off, 1 = on
6	T3	0 = off, 1 = on
7	T4	0 = off, 1 = on
8	reserved for future use	---
9	reserved for future use	---
10	reserved for future use	---
11	reserved for future use	---
12	reserved for future use	---
13	reserved for future use	---
14	reserved for future use	---
15	reserved for future use	---

This BoilerStatus3 Heat Demand Flag is Heat Demand input. On member boilers, this indicates a “Local Override”.

Troubleshooting

This section is included as an aide to help troubleshoot problems with the setup and operation of the boiler. See *Appendix A* for additional fault messages.

Situation:
Nothing happens when the power switch is turned on.

1. Check For 120/240 VAC on the Service connector J1. Verify the line power is connected as per wiring diagram. The Power switch light (ON - Position) should illuminate if this is wired correctly. If the light does not illuminate on the power switch, ensure that J7 is connected to the main board and the power switch.

2. If the Ignition Control is active, but the front panel display is inactive check:

    a. Cable and cable polarity from the control board to the display.

    b. J14 on control board. 120vac is routed from here to the transformer. The transformer returns 24vac to power the control.

    c. Check for 120vac on the primary of the transformer and 24vac on the secondary. If one of the 24vac interlocks has been shorted to ground or the 24vac output is low, the transformer may be damaged or a 24vac circuit may be miss-wired.

NOTICE The H-Net control is equipped with resettable fuses on the power input circuit. Wiring power incorrectly to the unit will cause these fuses to open. Once the incorrect wiring is corrected, the fuses should reset themselves in less than 5 minutes.

Situation:
You get the error message for the Combustion Air Damper.

1. The prove switch for the combustion air damper is not closing. Check to make sure the dampers are being controlled by the output relay. Also check to make sure the prove switch is wired and working properly.

2. If (1.) has been done and you are using SPARE 1 and you continue to get the error message, check the sensor TYPE specified for sensor #5 in the sensors menu. If it is set to NONE the controller will not recognize the closed circuit. Set the Sensor #5 to ON/OFF.

3. If you are not using the combustion air damper then it needs to be disabled in the AUX FUNCTIONS menu.

Situation:
The display is displaying random characters or the control keeps resetting.

There may exist a grounding problem with the controller or one of the boilers, pumps, contactors or other devices connected to it. If all grounding is correct, there may be an issue with radiated or induced electrical noise (interference). This may be caused by, arcing across a contactor's contacts when starting a pump motor, or a large electrical load. It may also be caused by, the ignition transformer being improperly grounded, or the spark gap set incorrectly.

1. Attempt to identify the noise source:

2. What is the boiler/controller trying to do at the time of the failure?

3. Is the boiler on the same circuit as the noise source? (the boiler should have isolated power.)

4. Are shielded sensor wires used? (Ensure the shields are grounded only at the boiler control end.)

5. Are any sensors or sensor wires located near a transmitting antenna? (Move sensor)

Situation:
There are no heating boilers on.

1. Check the settings for WWS SETPOINT, WARM WEATHER SHUTDOWN; if the outdoor air temperature is above the WWS SETPOINT and WARM WEATHER SHUTDOWN is set to YES, the circulator pump relay will be locked out and the heating boilers will not fire.

2. If the water temperature is within the heating band around the setpoint, boilers will not come on. The water temperature must fall below the lower band limit to begin firing boilers.

Situation:
Unable to change the # of Boilers in the BOILERS menu.

1. In H-Net method, the KN-Series control auto-detects the boilers in the system and adjusts the # of boilers accordingly.

2. Using H-NET, if the # of Boilers is not being adjusted properly to the actual amount of boilers in the system, check each boiler. There can only be (1) master boiler, but there can be up to 15 member boilers. Currently, a total of 16 boilers in a system.

Situation:
The boilers menu only indicates 1 boiler, but there are member boilers connected and the amber light blinks on all of the boilers communication's jacks.

1. Ensure that the latest version of firmware is installed on all boilers. All boilers in a system must have the same firmware revision.

2. Ensure the proper termination is set on the Master and the last Member boiler.

Situation:
You get the error message – WATER FLOW SWITCH or WAITING FOR FLOW.

1. If the control does not sense a closed circuit at input connection, WTR FLW. Check to make sure the circuit for the circulator pump is correct, that the pump is being energized, and that the flow prove switch is working properly.

2. If there is no flow prove switch, check to make sure that a jumper wire has been hooked up to J11B, WTR FLW interlock.

Situation:
H-Net boilers are detected but then lost and then detected again etc...

1. The H-Net communications cable may be receiving interference from the blower, ignition, or other form of radiated electrical noise. Termination of the jumpers may not be correct or there is more than one master.

    a. Ensure that the termination jumpers are set on the MASTER boiler and only the LAST MEMBER boiler. All of the other member boilers should have their termination jumpers in the non-terminated position.

    b. There may be (2) or more MASTER boilers. Ensure that only one header sensor is present and connected to the SYS/DHW input. There should be no wires or sensors connected to the SYS/DHW input if the boiler is operating as a member. This input is auto detected and defines the boiler as a MASTER.

    c. Ensure the cable to connect the H-Net is of a shielded or twisted pair type. Shielding of the cable is required.

    d. Minimize the electrical interference by routing the communications cable away from electrical noise sources, such as: Motors, ignition controls, contactors etc…

Situation:
Only the MASTER boiler Fires, but the system has many boilers and is using H-Net.

1. In order for the MASTER boiler to act as a MASTER, the header sensor must be set to TYPEZ, and there must be a header sensor present. At power-up, the header sensor is auto detected. If the temperature of the header sensor at power-up is greater than –25 F and less than 240 F it is considered a valid sensor. The boiler will default to the MEMBER mode if the temperature is not in this range and can only be run locally or by external inputs.

    a. If the LOAD FACTORY DEFAULTS has been used to restore all the default settings, the header sensor has been set to NONE. This needs to be set as stated in 1, and the header sensor will need to be replaced or the temperature brought into a valid range. A power cycle of the boiler will detect the sensor if it is in the range as stated in 1.).

    b. The H-Net needs a communications cable daisy-chained between boilers. Ensure that a good connection is made on the communications board and that the lights on the dual RJ45 jack flash (roughly twice a second). The MASTER is the only one that should flash with no communications cables plugged in.

Situation:
I am in CALIBRATE and I cannot fire the boiler to adjust it.

1. Only one, but any one of the T1-T2 inputs can be used to start the boiler. All other inputs are disabled. This method prevents an external control or Building Management System from trying to control the boiler while it is offline and being calibrated. If the boiler is

being used as a staged boiler controlled by an external control, the staged inputs need to be disconnected before CALIBRATION, since more than one of the T inputs may be closed by the external control.

Situation:
You have forgotten the password.

2. As a last resort, you can turn the controller off, then depress and hold the ESC key while turning it back on. This will load the default password "AAAAAA".

Situation:
Firmware update program starts to load, but then stops, or does not load at all.

1. Check that the termination shunts J3 and J6 are not in the termination setting. If they are, remove them temporarily while updating. Restore them for proper communication with a building management system.

2. Ensure that the USB driver for your PC/Laptop computer is properly installed.

3. Disconnect BMS or Protocessor Module if connected.

Situation:
All HeatNet Boilers fire at the same time.

1. This is usually caused by the HeatNet addresses on the Member boilers not being set. If the address on each boiler is not set, then all boilers will have address = 2 by default. When the Master boiler calls to fire boiler #2, all boilers with address #2 will fire. Set each Member boiler to a unique address from 2-16.

2. Check the ADD Boiler delay time to ensure it is at a reasonable value. A setting of 0 will start all the boilers at the same time.

Situation:
The boiler is showing that it is running at 45% and there is no fire in the sight glass.

1. The Boiler always shows it's called for firing modulation %. This is not an indication of what the boiler is actually firing at. If the ignition control fails to receive a call to fire (last interlock closed on terminal 6 of the ignition control) the display will indicate the called for %. Check if the ignition control is in standby, if so then the HeatNet control has closed the Start contact on J5..10 (Limits) and is waiting for the Blower relay to close on the ignition control which is monitored on J5.3 of the HeatNet control.

Situation:
I can hear the blower ramping up and down and the firing rate is changing, but the display indicates it is running at the same modulation rate.

1. The Boiler always shows it's called for firing modulation %. This is not an indication of what the boiler is actually firing at. In this case, the boiler is trying to meet the called for modulation % which is displayed, but is unable to do so. The boiler protects itself by looking at it's supply water temperature and the temperature is probably in the Operating Limit Band. While in the operating limit band, the HeatNet control limits the input of the boiler. The boiler tries to deliver the most input it can in an attempt to meet the called for modulation % without tripping the operating limit.

2. If the boiler is constantly varying in blower speed and in the operating limit band there may be not enough flow through the boiler or the Operating Limit/Operating Limit Band may be improperly set. The Operating Limit/Operating Limit Band should not overlap the heating band. This may occur when a building management system is controlling the setpoint and is setting the setpoint in the operating limit band.

3. Example: Setpoint set to 180F (by Building Management) and the Operating Limit is set to 200F with a 20F Operating Limit Band. When the boiler is trying to deliver 180F to the load it's supply temperature would be a minimum of 180F. The beginning of the Operating Limit Band (looks at supply temp) would be 200F-20F = 180F. Now, when the Master is trying to maintain setpoint at 180F, the boiler is trying to reduce input beginning at 180F at its supply sensor and as a result, fighting the setpoint. The Operating Limit band needs to be reduced in this case, while taking into account the Heat Band differential.

Situation:
The Master boiler sees all of the Member boilers in the system, but does not fire any of the Members.

1. If the Master modulates to 100% without firing a Member boiler and the Member boilers are seen by the Master (in menu SETUP:BOILERS), then the Member boilers are sending back offline status to the Master.

    a. The Member boilers may have an alarm or error condition which would be indicated by a blinking boiler # in the Boilers Firing screen.

    b. Ensure the HeatNet is set up properly: Amber lights blink on HeatNet Jacks. Only one Master boiler.

c. If the Member boiler is in Local Mode then it also would not be called and report unavailable to the Master.

d. If the Local flow switch for the Local pump is wired to the System flow switch input this would also create an offline condition. The Member needs to detect system flow or have a jumper across that sensor input in order for the Member boiler to report available status. The Local flow prove switch must be wired to the Water Flow interlock sensor input.

Situation:
We are trying to use a 0-10VDC control signal, but when we send it 10 VDC only 7 VDC is measured at terminal
J10B 6 & 7.

1. The HeatNet control was designed to use a 4-20mA control input. If a 0-10 VDC control signal is to be used, it must supply at least 20mA. O-10 VDC control signals are not recommended due to line loss and the ability of the control signal to reject noise. So, if using a 0-10 VDC control signal it must be able to supply the 20mA.

Situation:
We are using a BACnet or LonWorks bridge. We can talk to the bridge, but all of the data is zero (0) or invalid.

This condition usually indicates that the bridge is not communicating with the HeatNet control. When operating properly, the bridge continuously reads data from the boiler on the Modbus port into an internal buffer. When a BACnet or LonWorks read request is received, the buffered values are placed in a BACnet or LonWorks packet and sent. If the bridge has never been able to successfully read data from the control, all data points will have their default value which is typically zero. In this situation, the control will also not respond to write commands; for instance changing the setpoint.

1. The control's **MODBUS ADDRESS** must be set to one (1). This is set in the **ADVANCED SETUP->DISTRIBUTED CONTROL** menu. On older (legacy) firmware this setting was also called the **CONSOLE ADDRESS**.

2. The control' **BAUD** (rate) must be set to 19200 and the **DATA FORMAT** must be set to **8E1** (8 data bits, even parity, 1 stop bit). On older (legacy) versions of firmware, the **DATA FORMAT** was called **PARITY** which must be set to **EVEN**. These settings are set in the **ADVANCED SETUP->COMMUNICATIONS** menu.

3. Check the termination on the BMS/Modbus port. If the control is the first or last device on the Modbus RTU network, it should be terminated. For the short cable runs (for instance when using a BACnet or LonWorks bridge on a Revision 1.x board), the termination should be in, but usually doesn't matter.

4. Check the wiring. The Modbus RTU (RS485) connections on the HeatNet control are A(+), B(-), and G (ground). Some systems use opposite polarity; A(-), B(+). Always use the polarity to determine the proper connections. **A ground wire must always be used and a shielded twisted wire is STRONGLY suggested.**

5. The HeatNet LonWorks and BACnet bridges plug directly into Revision 2.x+ boards. Legacy boards (Revision 1.x) required a ProtoCarrier to provide power and the RS485 signal conversion to the bridge. The RS845 signal conversion chips are easily damaged by electrical noise, ground loops, and large differences in ground potential between devices on the network. This is a common problem faced by all RS485 devices, not just the HeatNet control. To help eliminate grounding problems, nylon standoffs are required to isolate the bridge from the boiler chassis. The ProtoCarrier should also be powered from the 24VDC output on the HeatNet control to help eliminate electrical noise (VFD and spark pickup, power spikes, etc.) on the power supply lines. Please download complete HeatNet bridge installation instructions from the product web site.

   a. When the ProtoCarrier is functional, the small green surface mount TX and RX LEDs near the 6-pin connector (power and communications) should be flashing regularly.

   b. If the TX LED flashes very briefly about once per minute, the ProtoCarrier has most likely been damaged, please contact Tech Services.

   c. If either LED is always on, the ProtoCarrier has most likely been damaged, please contact Tech Services.

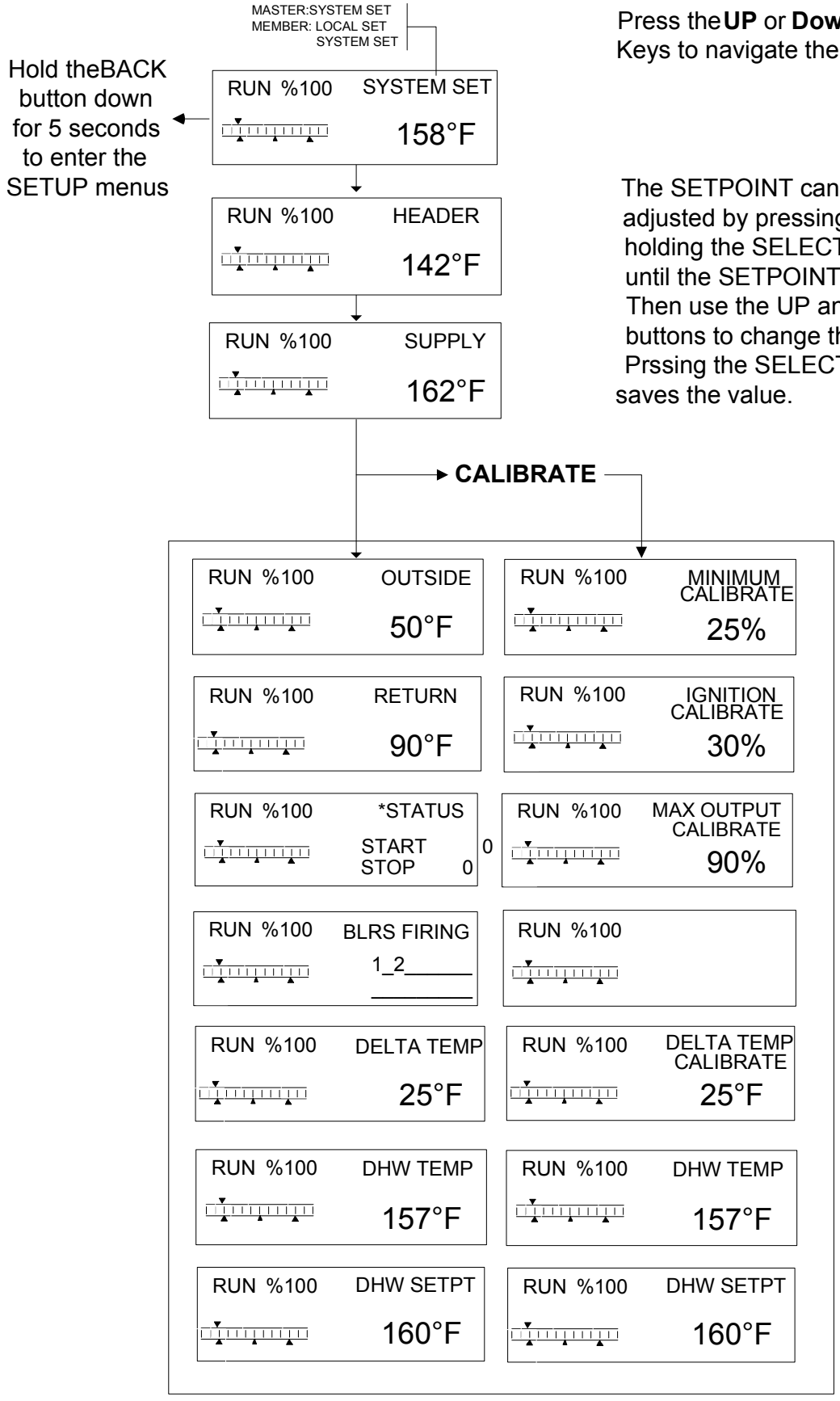
Situation:
We are using a Building Management System (BMS) to control the boilers. We can write the setpoints, but they keep changing back to their "default" values after approximately 60 seconds.

1. When using a BMS, the setpoint values work in conjunction with the **SETPOINT TIMER**. The **SETPOINT TIMER** is a failsafe feature used to help detect that a BMS is no longer working or communicating with the control. The time must be regularly loaded with a predetermined number of seconds (1 – 65535). Every second this value will decremented. If it reaches zero, the local (permanently saved) values for the setpoints will be loaded. The concept is that periodically (or every time a setpoint is written), the BMS must write this value. If the value reaches zero (0), the HeatNet control assumes that the BMS in no longer functional and "safe" operational values for the setpoints will be restored. As an example, if it is decided that the BMS will write the control every 5 minutes, you may decide to write 600 seconds (10 minutes) to the setpoint timer. If after 10 minutes (5 minutes longer than the normal write interval) the BMS has not written the timer, the saved setpoint values will be restored.

2. As a convenience, the **SETPOINT TIMER** is automatically loaded with 60 seconds (if it has fallen below 60) each time the setpoint is written. If you decide to take advantage of this convenience, you would need to write the setpoint periodically at less than 1 minute intervals.

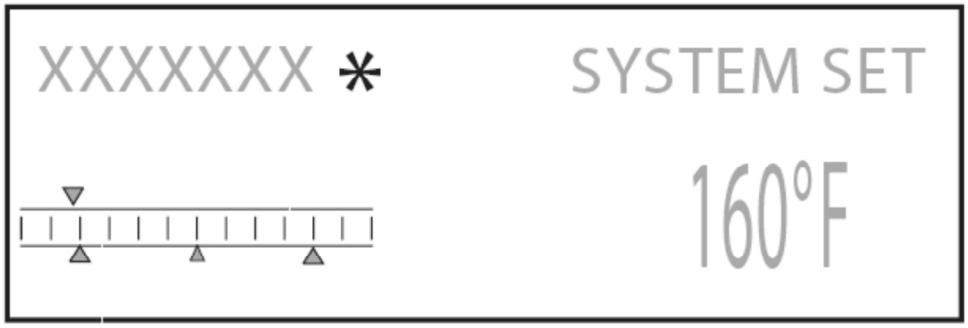
3. Newer firmware versions allow the **SETPOINT TIMER** failsafe feature to be disabled by writing a zero (0) to the timer. The feature will automatically revert back to the enabled state whenever the control is reset or power cycled. The **SETPOINT TIMER** failsafe feature can permanently disabled (or enabled) in firmware versions **3.35** or greater. This setting can be changed in the **ADVANCED SETUP->COMMUNICATIONS** menu.

KN HeatNet Control Run Screen

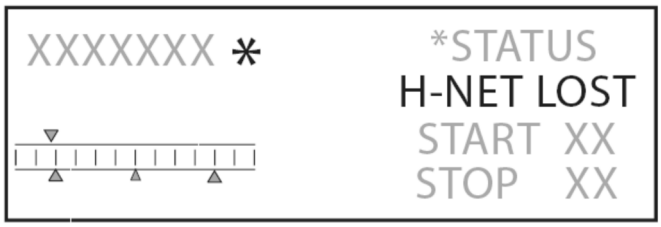


* Status Information

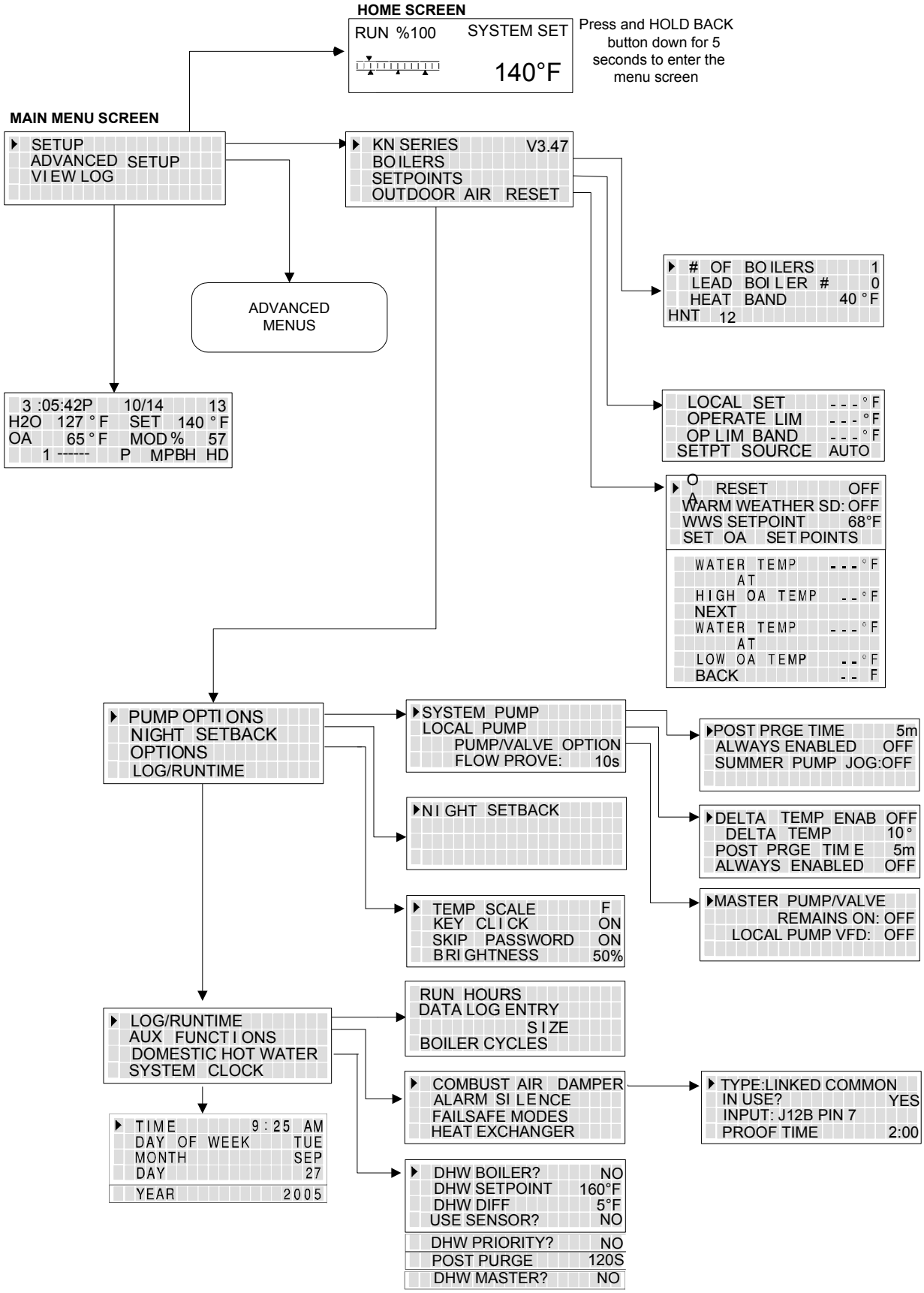
Whenever an * is displayed on the RUN screen it indicates that there is more information available about the current running conditions. This information can be viewed by going to the *STATUS screen as shown on the previous page. For more information on the parameters discussed here please see the Default Settings & Menu Item Descriptions — SETUP, starting on page 52.



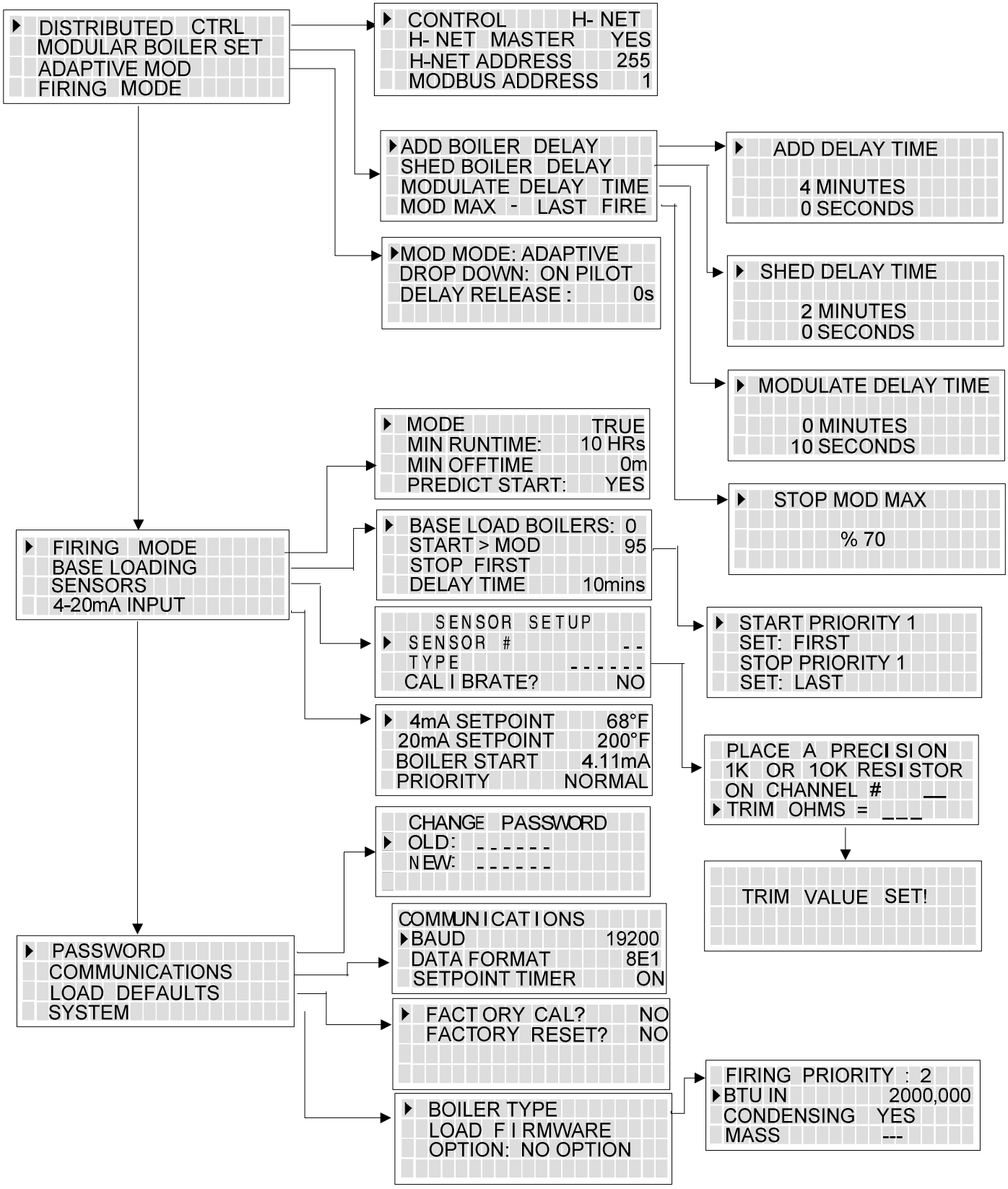
Status information screens	
	This screen indicates that the boiler's SUPPLY Temperature has gone above the OPERATOR LIMIT. This will mainly be seen on member boilers to show why they are not available to fire.
	This screen indicates that the boiler's SUPPLY temperature has risen inside the OPERATOR LIMIT BAND.
	This screen indicates the boiler's input is being limited by the MOD-MAX value to optimize system efficiency. This will only be seen on a MASTER boiler.

Status information screens	
	This screen indicates the control is attempting to re-initiate the ignition control because the ignition control did not begin PRE-PURGE. For more information see CALL SERVICE LOG entry.
	This screen indicates that the boiler's has received a heat demand, but it's MINIMUM OFF time has not expired.
	This Screen indicates that the boiler's input is temporarily being limited to optimize the boiler's efficiency.
	This screen indicates that the boiler is running in LOCAL MODE because it has lost H-NET communications with the MASTER, and the failsafe mode has been activated.

KN HeatNet Control Menu Tree — Hydrotherm Version 3.47



KN HeatNet Control Advanced Menu Tree — Hydrotherm Version 3.47



Worksheet

SETUP MENU				
BOILERS				
# of BOILERS				
LEAD STAGE				
HEAT BAND	°			
SETPOINTS				
LOCAL SETPOINT	°			
OPERATE LIMIT	°			
OP LIM BAND	°			
SETPOINT SOURCE				
OUTDOOR AIR RESET	°			
OA RESET				
WARM WEATHER SD				
WWS SETPOINT	°			
SET OA SETPOINTS				
WATER TEMP	°			
@				
HIGH OA TEMP	°			
WATER TEMP	°			
@				
LOW OA TEMP	°			
PUMP OPTIONS				
SYSTEM PUMP				
POST PURGE TIME				
ALWAYS ENABLED				
SUMMER PUMP JOG				
LOCAL PUMP				
DELTA TEMP ENAB				
DELTA TEMP	°			
POST PRGE TIME	s			
ALWAYS ENABLED				
PUMP/VALVE OPTION				
REMAINS ON:				
LOCAL PUMP VFD				
FLOW PROVE				
NIGHT SETBACK				
SETBACK ENTRY	1	2	3	4
ENTRY IS				
SETBACK	°	°	°	°
SETBACK TIME				
START DAY				

TIME				
END DAY				
TIME				
OPTIONS				
TEMP SCALE	°			
KEY CLICK				
SKIP PASSWORD				
BRIGHTNESS	%			
LOG/ RUNTIME				
RUN HOURS				
DATA LOG ENTRY				
SIZE				
BOILER CYCLES				
AUX FUNCTIONS				
COMBUST AIR DAMPER				
TYPE:				
IN USE?				
INPUT:				
PROOF TIME				
ALARM SILENCE SWITCH				
IN USE				
INPUT:				
FAILSAFE MODES				
H-NET COMM LOST				
LOW TEMP:				
TEMP <				
HEAT EXCHANGER				
EXCHGR DELTA T				
LIMIT-> HALF RATE				
DHW SETPOINT				
DHW DIFF				
USE SENSOR?				
DHW PRIORITY?				
POST PURGE				
DHW MASTER?				
SYSTEM CLOCK				

ADVANCED SETUP								
DISTRIBUTED CTRL								
CONTROL								
H-Net MASTER								
H-NET ADDRESS								
MODBUS ADDRESS								
MODULAR BOILER SET								
ADD BOILER DELAY								
SHED BOILER DELAY								
MODULATE DELAY TIME								
MOD MAX – LAST FIRE	%							
ADAPTIVE MOD								
MOD MODE:								
DROP DOWN								
DELAY RELEASE								
FIRING MODE								
MODE								
MIXED START PRIORITY 1								
SET:								
STOP PRIORITY 1								
SET:								
MIN RUNTIME								
MIN OFF TIME								
PREDICT START								
BASE LOADING								
BASE LOAD BOILERS:								
START > MOD								
STOP								
DELAY TIME								
SENSORS								
SENSOR #	OUTDSIDE	SUPPLY	R E T U R N	H E A D E R	DHW	6	7	8
TYPE								
4-20mA INPUT								
4mA SETPOINT								
20mA SETPOINT								
BOILER START								
PRIORITY								
PASSWORD								
COMMUNICATIONS								
BAUD								
DATA FORMAT								
SETPOINT TIMER								

SYSTEM				
BOILER TYPE				
LOAD FIRMWARE	Version:			
OPTION:				

CALIBRATION SETTINGS

MIN VFD	
IGN VFD	
MAX VFD	

Thermistor Resistance/Temperature Table

Temp °C	Temp °F	Resistance	Temp °C	Temp °F	Resistance
-40	-40	336,450	60	140	2,488
-35	-31	242,660	65	149	2,083
-30	-22	176,960	70	158	1,752
-25	-13	130,410	75	167	1,479
-20	-4	97,072	80	176	1,255
-15	5	72,951	85	185	1,070
-10	14	55,326	90	194	915.4
-5	23	43,326	95	203	786.6
0	32	32,650	100	212	678.6
5	41	25,391	105	221	587.6
10	50	19,899	110	230	510.6
15	59	15,711	115	239	445.2
20	68	12,492	120	248	389.6
25	77	10,000	125	257	341.9
30	86	8,057	130	266	301.0
35	95	6,531	135	275	265.8
40	104	5,326	140	284	235.4
45	113	4,368	145	293	209.0
50	122	3,602	150	302	186.1
55	131	2,986			

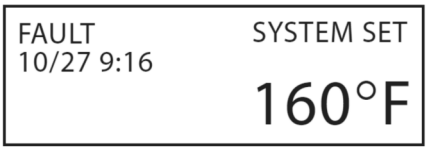
Status Screen Fault Display

There are numerous interlock switches and software limits that are detected. Each of these, when tripped will produce a display message, an audible beeping, and an alarm relay closure. The fault is displayed first, then after a second, the time the fault occurred is displayed. This cycle will keep occurring until the fault is cleared.

These faults and interlocks are:

HIGH LIMIT:

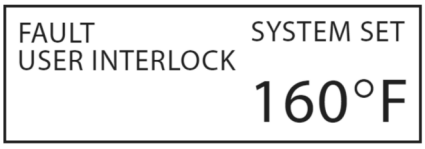
When the high limit aquastat trips the following message is displayed:



The high limit interlock breaks power to the ignition control (shutting it off) and effectively removes any chance of the gas valve receiving power. The HeatNet series control will remain powered to display the fault, latch the alarm relay/audible beeper, and to access the log. The interlock is located on J5, HIGH LIMIT. Ensure power is present on the input to the High Limit Control.

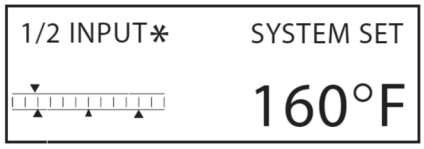
SPARE 4:

This is a reserved interlock input that is user defined. The interlock is located on J5B, SPARE 4.



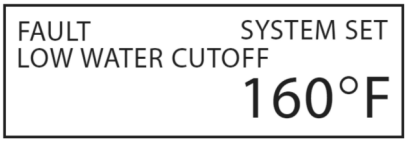
DELTA TEMPERATURE WARNING:

If the temperature difference across the boiler measured from RETURN water to SUPPLY water exceeds the EXCHR DELTA T RANGE, setting this message will be displayed.



LOW WATER CUTOFF:

If there is a low water condition reported by the low water cutoff switch this fault is displayed. Check that there is water flow and water in the boiler. There is a reset switch located on the LWCO box. The interlock connection is located on J5B, LWCO.

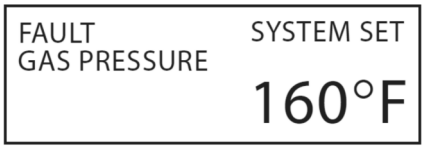


VAR FREQ DRIVE:

The variable frequency drive, which controls the blower, if supported, reports this fault in the event of over current or other conditions that would cause it to shut down. If this is the case, check the fault indicators on the VFD. The interlock is located on J5B, VFD.

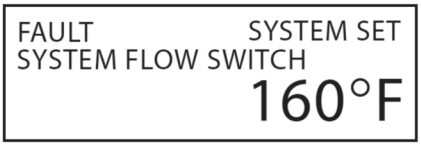
GAS PRESSURE:

The gas pressure switches (high pressure and low pressure) are connected in series, so if either trip, a fault will be reported here. A reset switch is located on the gas pressure switches. The interlock is located on J15B, GAS PR.



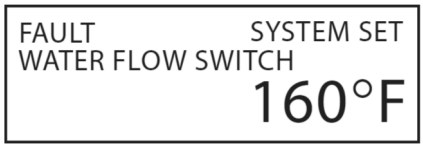
SYSTEM WATER FLOW:

Once the HeatNet series boiler receives a call for heat, it closes the system circulator pump relay. It then waits 10 seconds or more (adjustable) to prove flow. If there is no flow, the flow switch alarm will be set. Every 10 seconds the circulator pump relay will cycle ON for 10 seconds and then OFF for 10 seconds to try and establish flow. The interlock connection is located on J5B, SYSTEM WTR FLOW.



WTR FLW LOCAL:

Once the HeatNet series boiler receives a call for heat, it closes the LOCAL PUMP/VALVE relay. It then waits 10 seconds or more (adjustable) to prove flow. If there is no flow, the flow switch alarm will be set. Every 10 seconds the circulator pump relay will cycle ON for 10 seconds and then OFF for 10 seconds to try and establish flow. The interlock connection is located on J5B, WTR FLW.



IGNITION CTRL ALARM:

The ignition control alarm is displayed if the ignition control detects a fault. This could be a flame failure, air proving switch, or other fault associated with the ignition control. When this fault occurs, you will need to refer to the ignition control for the reason.

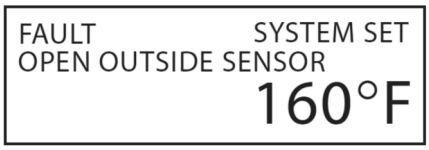
COMBUST AIR DAMPER:

If the combustion air damper has been selected for use (AUX FUNCTIONS), and the proof switch does not make, this fault will be displayed.

When the master boiler receives a call for heat and needs to start a boiler, the DAMPER relay closes on J13. If the combustion air damper does not prove within the proof time specified in the combustion air damper menu, the boiler will not start and then display the fault. A combustion damper fault on a boiler can only be cleared by power cycling.

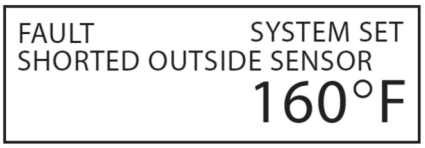
OPEN ******* SENSOR :

If the open sensor fault is displayed, the sensor in the position reported was originally detected, but has since opened. The boiler will shut down on any OPEN sensor except the OUSTSIDE AIR sensor.



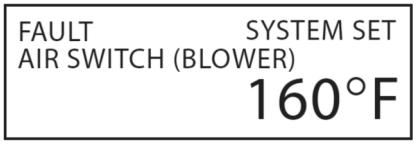
SHORTED ******* SENSOR:

If the shorted sensor fault is displayed, the sensor in the position reported was originally detected, but has since shorted. The boiler will shut down on any SHORTED sensor except the OUSTSIDE AIR sensor.



AIR SWITCH:

If the IGNITION control closes its blower relay, the control does not see the PILOT relay close within (2) minutes, and the AIR PRESSURE switch is made, this message will be displayed. This alarm protects the boiler from freeze ups being caused by a blower bringing in cold outside air with no fire.

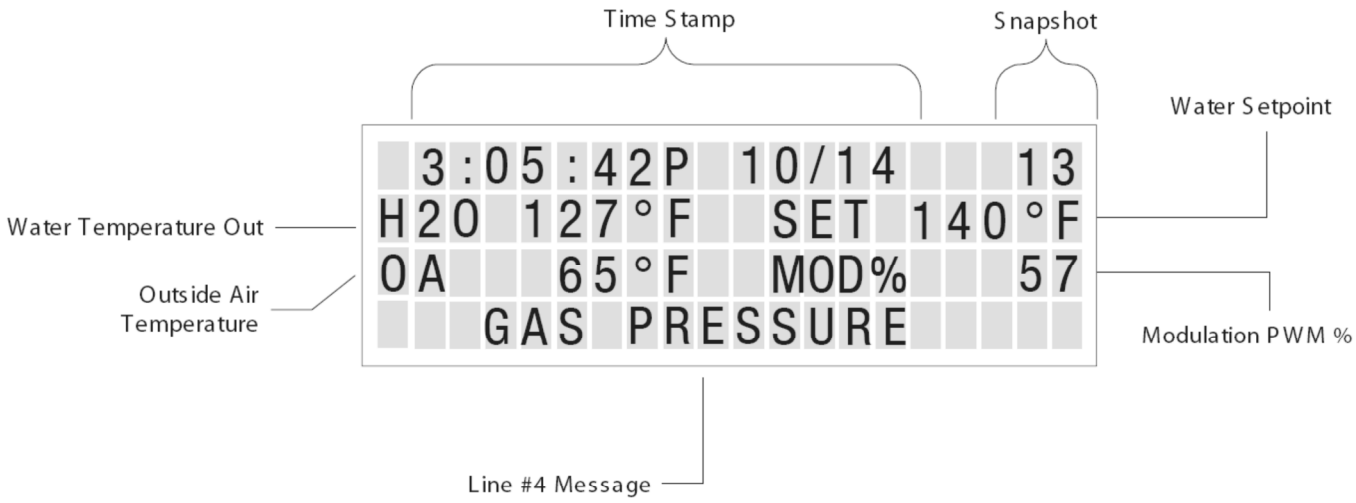


CALL SERVICE:

If the H-Net control closes the last interlock string entering the ignition control and the ignition control never closes its Blower Relay, the H-Net control will wait 2 minutes. The H-Net control will then retry for the duration of the local pump post purge time and then retry the ignition sequence. During this time “retry strt” will be displayed in the status screen. After (5) attempts the H-Net control will lock out and display call service.

Line 4 Log Entries:

The following table lists the messages on line # 4 of the log's display.



Line # 4 Message	Description
SETBACK IS ACTIVE SETBACK EXPIRED	If any of the (4) temperature setbacks are active these log entries will be displayed in the log.
NO LOCAL FLOW NO SYSTEM FLOW	If the test for flow fails these log entries will be displayed. The flow proving switches are wired to J11A and J11B.
COMBUSTION AIR FAIL	If the combustion air damper is used and does not prove across J10B DAMPER or J12B DAMPER, this message is displayed.
SYSTEM RESET -- ---- O: stack overflow, U: Stack Underflow (both are software faults) R: Reset Instruction (Firmware or Default load), W: Watchdog (Firmware code ran erroneous code and rebooted), P: Power-ON (Power switch toggled), B: Brown-out (Microcontroller saw a voltage less than 4.5 VDC)	When the control is reset, this log entry captures the reason the reset occurred.
OUTDOOR RESET	This log entry indicates that Warm Weather Shutdown is in effect.

Line # 4 Message	Description
HIGH DELTA TEMP	This log entry occurs when the temperature across the heat exchanger has been greater than the EXCHR DELTA T RANGE degrees F.
SHUTDOWN UV TEST	After 24 hours of continuous runtime the ignition control module needs to check it's UV detection circuit. An orderly shutdown and then a restart will occur. This log entry indicates that this has taken place. This is not a fault.
HIGH LIMIT EXCEEDED	If the mechanical aguastat trips due to it's high temperature setting having been exceeded, this log entry will occur.
IGNITION CTRL ALARM	The ignition control module has faulted while performing an ignition sequence, or while monitoring flame during normal operation.
IRI Alarm	If the gas valve proving circuit (if equipped) detects a gas pressure problem.
DOMESTIC HOT WATER	Indicates a call for DHW heating by either the DHW sensor or an external thermostat.
LOW WATER CUTOFF VAR FREQ DRIVE GAS PRESSURE SPARE 4 OP LIMIT MECH	These log entry faults are result of the interlocks connected to the 24VAC interlock inputs: J11A and J11B. Low Water Cutoff = Low water condition in boiler Var Freq Drive = The blowers Variable Frequency Drive has a problem Spare 4 = User installed interlock, Op Lim Mech = An external operator (aquastat).
START FAILED, RETRY	If the H-Net control closes the last interlock string entering the ignition control and the ignition control never closes its Blower Relay, the H-Net control will wait 2 minutes. The H-Net control will then retry for the duration of the local pump post purge time and then retry the ignition sequence. During this time "retry strt" will be displayed in the status screen. After (5) attempts the H-Net control will lock out and display call service. The Log will report the retries.
OP LIMIT REMOTE	The is the firmware Operating Limit as defined in SETUP:SETPOINTS:OPERATE LIM. When the Supply temperature exceeds this value, this event is logged.
OPEN OUTSIDE SENSOR, SUPPLY SENSOR, RETURN SENSOR, HEADER SENSOR, DHW SENSOR	If one of the 10k thermistor sensors was detected to be open or not connected, this fault will be logged.
SHORTED OUTSIDE SENSOR, SUPPLY SENSOR, RETURN SENSOR,	If one of the 10k thermistor sensors was detected to be shorted this fault will be logged.

Line # 4 Message	Description
HEADER SENSOR, DHW SENSOR	
AIR SWITCH(BLOWER)	If a call is made to the ignition control to start and the HeatNet control detects a blower start, but no Pilot within two minutes, the boiler locks out. This log entry indicates that the blower was ON with no flame in the boiler. Freeze up protection.
LOST BOILER # FOUND BOILER #	These log entries indicate that HeatNet has either discovered a boiler or lost a boiler using it's auto detection algorithm.
FAIL SAFE H-NET LOST FAIL SAFE LOW TEMP	If the Fail Safe modes are active, these log entries indicate that they became active for some reason and the boiler had entered Fail Safe mode.
BASE LOAD BOILER	The Base load Boiler Relay K8 is Active if ON Inactive if OFF
CALL SERVICE	If the H-Net control closes the last interlock string connected to the ignition control and the ignition control never closes its Blower Relay, the H-Net control will wait 2 minutes. The H-Net control will then retry for the duration of the local pump post purge time and then retry the ignition sequence. During this time "retry strt" will be displayed in the status screen. After (5) attempts the H-Net control will lock out and display call service.

HydroTherm®

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